SEP 3 1947

Mitchell TELESCOPE

Air view of McDonald Observatory

Ticket Trip Around the World

Northern and Southern Star Charts

Sky and TELESCOPE

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In Focus

PLATE XVIII in the series of moon pictures completes the last-quarter moon and the set. Once again, special acknowledgment and thanks are due the Lick Observatory of the University of California for supplying the excellent prints from which these reproductions have been made. The original first- and last-quarter negatives were taken by J. H. Moore and J. F. Chappell, using the visual focus of the Lick 36-inch refractor and a wedge-shaped focal-plane shutter which compensated for the decrease in intensity of the moon's brightness from limb to terminator.

Explanation of the method of producing the key charts may be of interest. A tracing was made of an engraver's proof of each back-cover plate, feature by feature, and these were identified and labeled using the large Blagg and Mueller atlas, Vol. II of **Named Lunar Formations**, official IAU publication. A list of features was made and checked against a master list copied from the British Astronomical Association's **Who's Who in the Moon.** Spellings were checked as conforming to the IAU authority, and features selected for In Focus on the basis of being fairly easily identified or those named for persons of interest because of their fame or their obscurity! After checking, each chart was lettered.

Of the 672 lunar features bearing individual names, 640 have been identified on the key charts; the remainder are invisible because of libration, and a few have been omitted through error. The first chart of the series did not attempt to include all named formations, and hence shows a large number of omissions:

Plate I. Brenner, Brisbane, Mallet, Peirescius, Reimarus, Weinek, Young.

Plate II: Daguerre (between Gaudibert and Maedler, but practically lost in the bleed between Plates I and II). Plate XIII: Gioja (very near the limb, north of Goldschmidt and west of Mouchez). Plate XIV: Mee (a bay with indeterminate borders just south of Hainzel). Plate XV: Draper (the northerly of the two small craters in Mare Imbrium north of Sinus Gay-Lussac and Pietrosul Bay).

Not appearing in the series because of libration are the following: Bailly, Boguslawsky, Boussingault, Bouvard, Cabaeus, Demonax, Doerfel Mts., Hanno, Hausen, Helmholtz, Inghirami, Legentil, Leibnitz Mts., Malapert, Mare Parvum, Marinus, Neumayer, Oken, Pingré, Pontécoulant, Schomberger.

Interest in the moon series has been so considerable, and the desire of many readers to make mosaics without cutting their magazines so frequently expressed, that Dr. C. D. Shane, director of Lick Observatory, has kindly consented to our distributing sets of these pictures "as long as the reproductions do credit to the originals." On the press at present, therefore, are the 18 back-cover plates, each printed on one side only of a sheet about 12 x 19 inches in size. In each set we shall include the key charts, with the key for Plate I redone to make them all uniform. Each set will be shipped anywhere for two dollars, postpaid.

Including the features discussed here for Plate XVIII, In Focus has now referred to 262 lunar formations.

Bessarion. A small crater in Oceanus Procellarum which was named for a Renaissance Greek churchman who lived and worked in Italy.

Galilaei. One of the great astronomers of all time was assigned this unimportant formation by Riccioli.

Herodotus. A walled formation over 20 miles in diameter lies southward from one end of the interesting Schroeter's Valley (see July, 1947, In Focus).

Hevelius. Practically lost under this illumination, this is a good-sized walled plain with a central mountain. Hevelius' **Selenographia**, published in 1647, was the first complete work on the moon, and contained drawings and maps for all phases. **Who's Who in the Moon** reports that his names for lunar features were taken from terrestrial geography, and only six survive.

Lavoisier. This walled formation near the limb was named for Antoine Laurent Lavoisier (1743-1794), famous French chemist, who founded a free school and engaged in a considerable number of philanthropic activities.

Marius. Simon Mayer (1570-1624) observed Jupiter's satellites in 1609, and claimed their discovery — a claim disputed

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SEPTEMBER, 1947

COVER: The McDonald Observatory of the University of Texas, which is operated by astronomers of Yerkes Observatory. It is located on Mt. Locke, near Fort Davis, Tex. This airplane photograph was taken by the U. S. Army Air Corps looking toward the southeast; the distant mountains are about 40 miles away. The top row of windows is in the observing chamber, where the 82-inch reflecting telescope is located. (See page 3.)

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BACK COVER: A portion of the moon near last quarter, from a Lick Observatory photograph taken with the 36-inch refractor by J. H. Moore and J. F. Chappell. This is Plate XVIII, and concludes the series. (See In Focus.)

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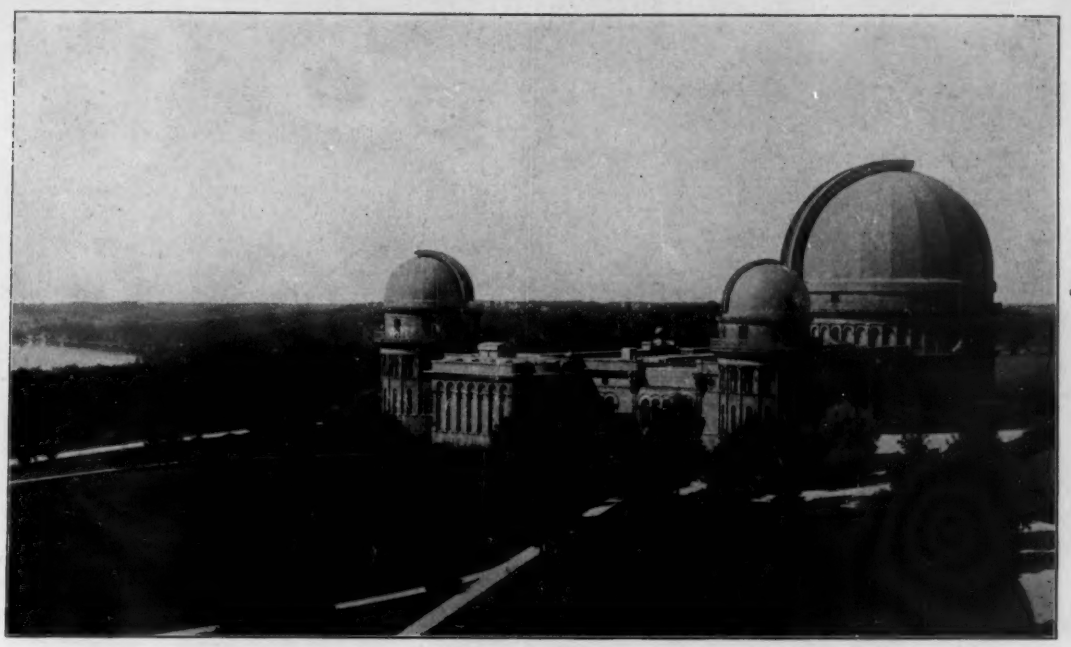


Yerkes Observatory overlooks Wisconsin's beautiful Lake Geneva.

Current Research at Yerkes Observatory

By W. A. Hiltner, *Yerkes Observatory*

THE YERKES OBSERVATORY of the University of Chicago was formally dedicated on October 18, 1897, and it seems appropriate on its 50th anniversary to discuss the investigations now being conducted here, with some comparison with the work inaugurated by George Ellery Hale, the first director. In discussing the programs of today, we shall also include those carried out at the McDonald Observatory of the University of Texas, which is operated by the Yerkes staff.

It was quickly recognized that the 40-inch refractor was unsurpassed for many investigations of an astrometric nature. The early work of E. E. Barnard and S. W. Burnham, and later by Frank Schlesinger, need hardly be mentioned. The present astrometric program consists principally of G. Van Biesbroeck's work on close double stars. These systems are especially useful, for from them we can expect the quickest results in the form of orbits which give data on stellar masses. In addition to using the 40-inch refractor, Dr. Van Biesbroeck has made extensive use of the 82-inch reflector at McDonald for measuring close double stars which are too difficult for the 40-inch.

The star of faintest known luminosity. One arrow points to BD + 4° 4048, a 9.2-magnitude star which has a yearly proper motion of 1.44 seconds of arc. The other arrow points at an 18th-magnitude star which travels through space with the former. From the distance of the brighter star, 19 light-years, the faint companion is found to be of absolute magnitude 19.2. Photograph taken at the prime focus of the 82-inch reflector by Dr. G. Van Biesbroeck.

In 1939, the year that the 82-inch was placed in service, Dr. Van Biesbroeck inaugurated a scouting program for the purpose of finding stars of faint luminosity. This project, which will be completed in several years, is done photographically at the prime focus of the 82-inch by searching for physical companions of stars of known high proper motion. A number of exciting objects have been found, including the star of faintest known absolute magnitude, 19.2, nearly a million times fainter than the sun!

K. Aa. Strand, a visiting professor, is employing the 40-inch for photographic observations of widely separated double stars, and R. Glenn Hall is the principal observer on the trigonometric parallax program. When the 40-inch is used for photographic purposes a panchromatic emulsion with a yellow filter in front is employed.

One of the principal programs at Yerkes and McDonald observatories is the investigation of the physical proper-

Messier 8 is a large, irregular galactic nebula in Sagittarius, visible to the naked eye as a fuzzy spot. The complicated structure shows luminous material and absorbing matter which appears as dark patches. Photograph taken at the prime focus of the 82-inch McDonald reflector by Dr. G. Van Biesbroeck; exposure time, 30 minutes.

ties of the outer layers of stars. This includes not only the recent studies of an observational nature by Otto Struve, J. L. Greenstein, D. M. Popper (now at the University of California), the writer, and others, but also the theoretical work by S. Chandrasekhar and his associates. Dr. Chandrasekhar has devoted considerable effort to the problem of radiation transfer in the sun. It is not necessary to look back very many years in order to find astronomers struggling with this problem, to find Rupert Wildt, now at Yale University Observatory, suggesting (in 1938) that the negative hydrogen ion may possibly account for the opacity of the sun, the disappointment when solutions of the absorption coefficient were made and found wanting, and finally, in 1946, Dr. Chandrasekhar's solution and computation of the exact absorption coefficient and its excellent agreement with the observed absorption coefficient in the sun.*

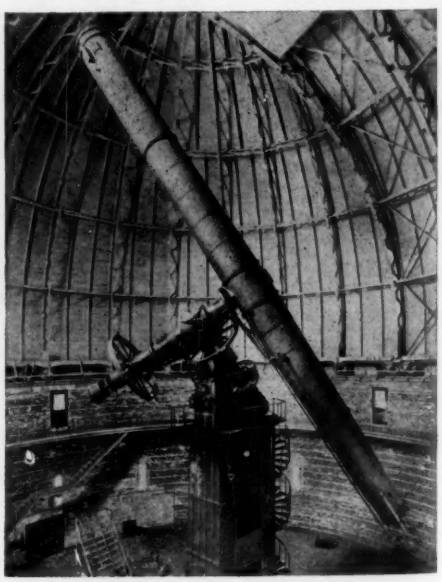
Another outcome from theoretical investigations by Dr. Chandrasekhar which is of general interest concerns the polarization of the continuous radiation from early-type stars. From studies by Dr. Greenstein at Yerkes and by others, it appears that in early-type stars whose surface temperatures exceed 15,000° the escape of radiation from the star must be principally controlled by the scattering of radiation by free electrons. This process must produce partial polarization of the radiation. Dr. Chandrasekhar has solved the problem exactly and has shown that the polarization at the limb of an early-type star may be as much as 12 per cent.

The presence of this effect provides a method of solving a problem which has heretofore been considered impossible, that is, the determination of the position angle of the orbit of an eclipsing binary. If free electrons control the transfer of radiation in stars of class *B*, then the light received from an eclipsing variable such as RY Persei (components $B4$ and $F5$) must be polarized throughout the partial phases of the primary eclipse, with a maximum effect of 1.2 per cent shortly before second contact and immediately after third contact. Observations of this star at Yerkes Observatory indicate that the effect is present and that the position angle of the orbit of RY Persei is of the order of 152 degrees.

Eclipsing variables have been given considerable attention at Yerkes and McDonald during the past few years, principally by Dr. Struve. A large number of such stars of special interest have been found. Rapidly rotating rings about the early-type component of the average eclipsing binary are often discovered. Ionized calcium clouds, frequently isolated at either extremity of tidally elongated stars, are the rule instead of the exception in eclipsing binaries in which both components are of late spectral type but in which the period is about two days or longer. Frequently, streams of gas are found flowing from one component to the other. Of special interest is UX Monocerotis, investigated by S. Gaposchkin, of Harvard Observatory, and more recently by Dr. Struve. The spectral changes found by the latter are so phenomenal that their exact interpretation will add valuable information to the general study of the evolution of binary systems.

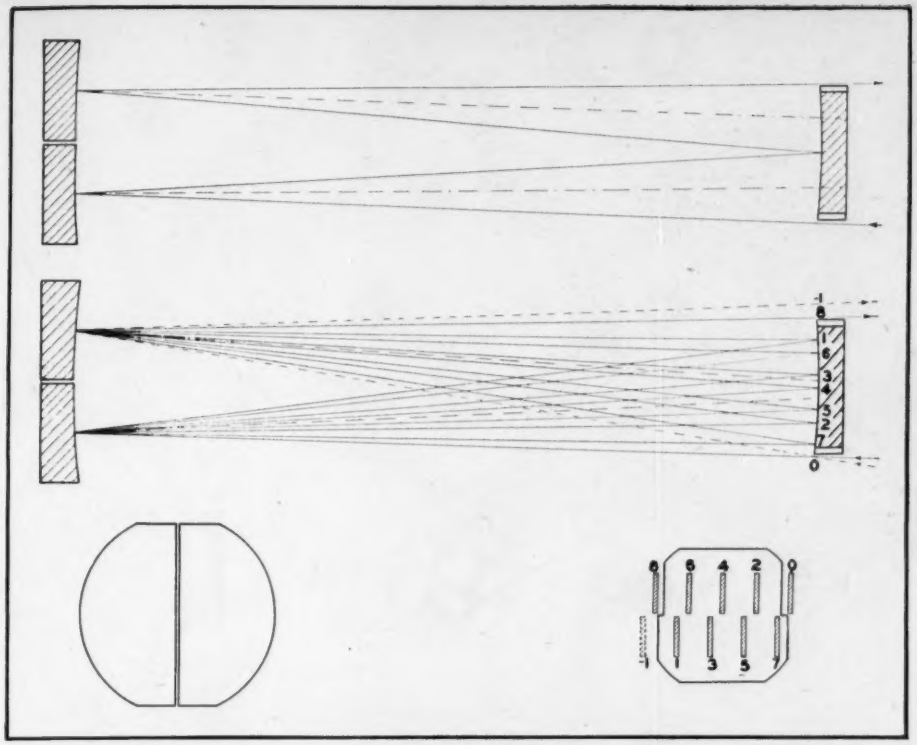
One cannot leave the field of the physical properties of the atmospheres of stars without dwelling on a subject which was dear to Professor Hale: close co-operation between the laboratory spectroscopist and the astronomer. When Yerkes Observatory was in the planning stage in 1893-94, it was he who stressed the necessity of a spectroscopic laboratory in an observatory, and during his stay at Yerkes his emphasis on laboratory spectroscopy bore much fruit. However, after his departure from Williams Bay to Mount Wilson in 1904, interest in this work gradually subsided. This was in part compensated for by physicists' work in spectroscopy during the first decades of this century. This interest rapidly faded as many problems in spectra were solved and the field became less fertile than nuclear studies, and today there are relatively few universities with strong spectroscopic laboratories.

With this in mind, G. Herzberg was invited to come to Yerkes some years ago to set up a spectroscopic laboratory. In addition to work on the molecules associated with late-type stars, the laboratory is devoting considerable time to studies of molecular gases with long absorption paths, particularly for comparison with the spectra of planets. It has been known



The world's largest refracting telescope is the 40-inch at Yerkes Observatory, now rounding out 50 years of operation.

*See page 2, *Sky and Telescope*, August, 1947.



The optical system of the absorption tube at Yerkes Observatory. Three concave mirrors of equal radius of curvature are used. Two of these, shown at the lower left, were cut from one circular mirror and are placed together at one end of the tube. The third mirror, shown at the lower right, is mounted at the other end at a distance equal to the radius of curvature. Light from a tungsten lamp is focused on an entrance slit at 0 (see the center drawing). The light then falls on the two mirrors at the otner end of the tube. The light from the top mirror is discarded (image -1), while that from the lower mirror forms image 1. This light is then reflected back to the top mirror, which in turn forms image 2, and the process is continued until the light emerges at 8 after traversing the tube 16 times. The mirrors can be adjusted so that light traverses the absorption tube at least 100 times (200 times appears feasible) before it emerges for analysis with a spectrograph or spectrometer. The tube is 75 feet long and 10 inches in diameter.

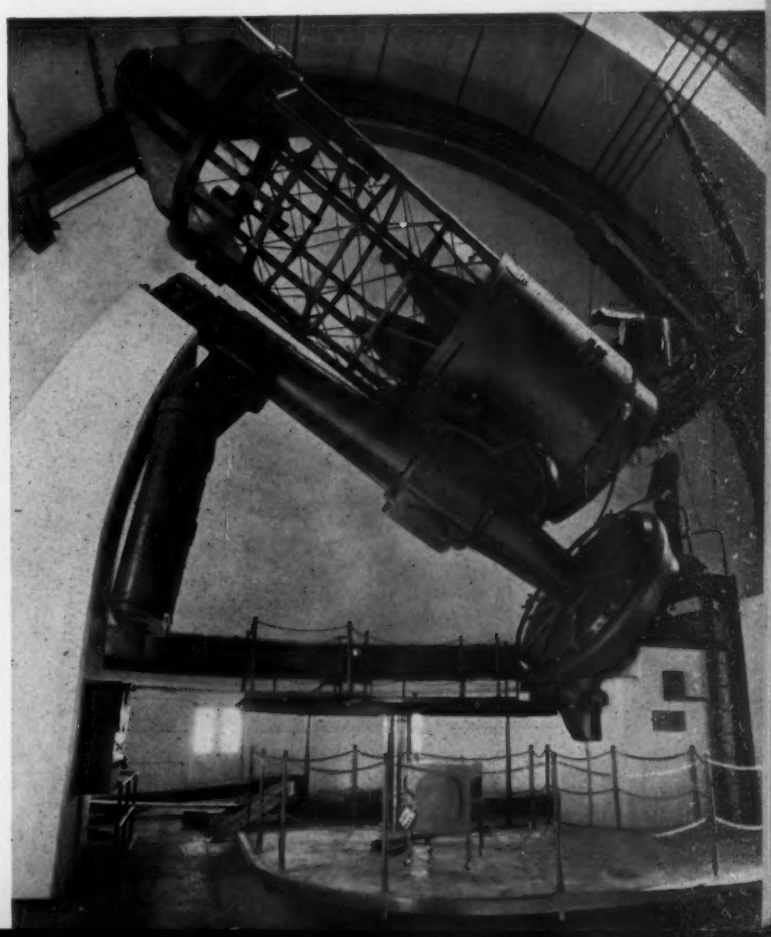
for many years that the major planets, Jupiter, Saturn, Uranus, and Neptune, show strong bands of methane (CH_4). Jupiter also shows ammonia (NH_3), and Venus has a dense atmosphere of carbon dioxide (CO_2). Normally, in the laboratory these molecules are investigated with short absorption paths, and in order to duplicate the intensity of the bands in the planets high pressure is necessary, but this broadens the lines so that the fine structure is lost. However, at Yerkes Observatory, Dr. Herzberg has an absorption tube 75 feet long. In this is located an optical system which causes the light of a continuous spectrum to traverse the length of the tube at least 100 times before the light enters the slit of a spectrograph, producing an absorption path about 1½ miles long. Preliminary data on carbon dioxide indicate that the amount of this gas on Venus is in excess of three quarters of a mile at atmospheric pressure, that the pressure of the gas on Venus is less than one atmosphere, and that the temperature is near room temperature.

A discussion of the absorption tube in the laboratory has brought us back to the solar system, a field in which one of the outstanding contributions from Yerkes has been Dr. Van Biesbroeck's many observations of comets, covering not only their positions but also descriptions of their physical features. Special attention has been given to comets which have become too faint for ordinary telescopes, so that the orbit of such an object can be well established by measurements continued long after it has been abandoned by most observers. The 24-inch reflector has proven a most efficient instrument for this work. This instrument has also been used extensively by Dr. Van Biesbroeck and others for obtaining positions of asteroids.

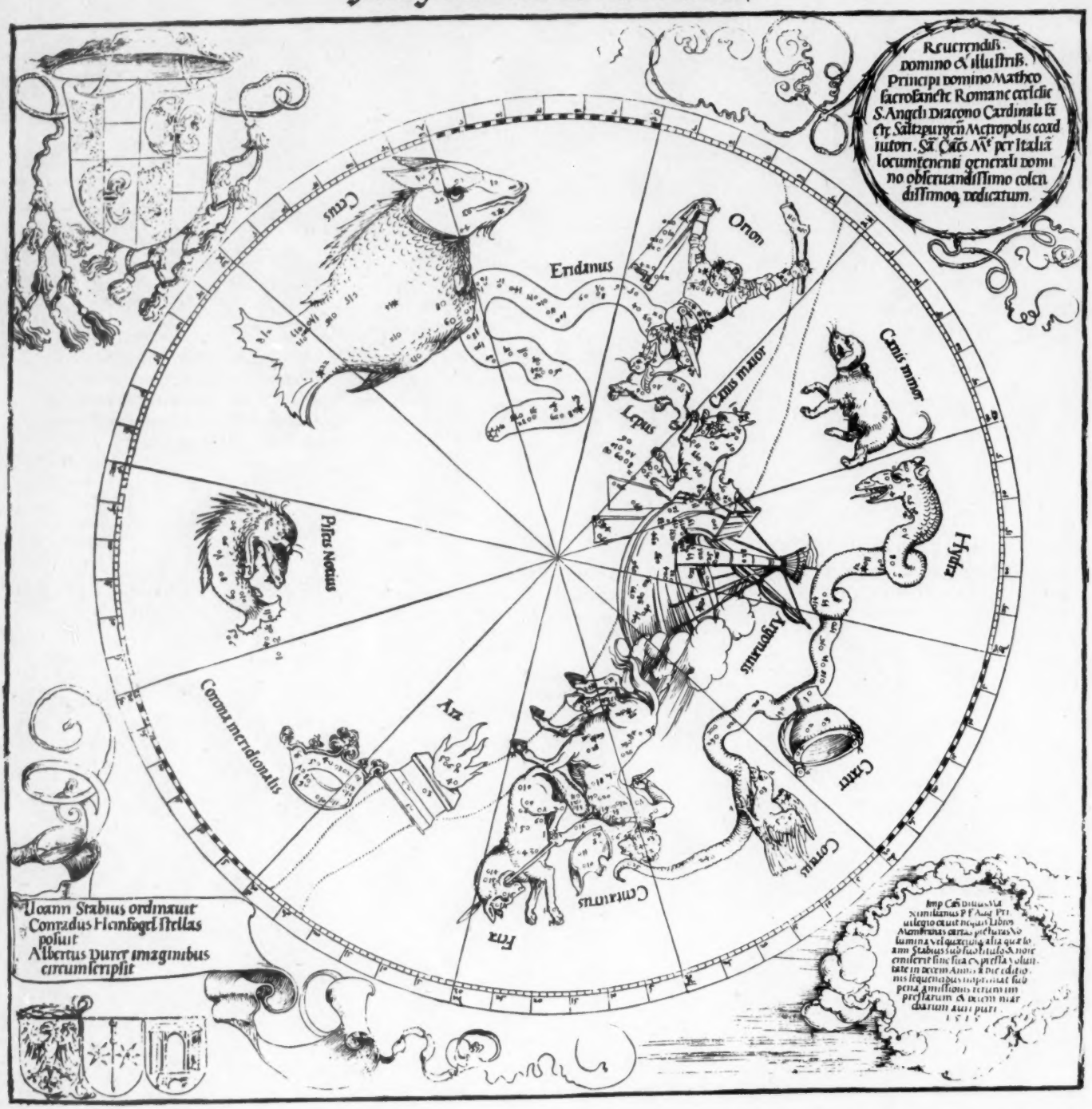
Of special interest to astronomers concerned with the origin of the solar system are G. P. Kuiper's spectrographic observations (with the 82-inch reflector) of the largest satellites in the solar system, and his discovery of an atmosphere of methane and possibly ammonia on Titan, the largest satellite of Saturn.

Important to investigators of the atmospheres of planets, as well as of late-type stars, is an infrared spectrometer designed by Dr. Kuiper in which the receiving element is a lead sulphide photoconductive cell developed by R. J. Cashman at Northwestern University. The spectral region in which the cell is sensitive is from 9000 to approximately 30,000 angstroms. Investigations of the planets and late-type stars have proven even more fruitful than expectations. Of popular interest (and otherwise) is a comparison of Alpha Leonis (*B*8), visual magnitude 1.3, and R Leonis (*M*8e), visual magnitude 10.5 at the time of observation. Although Regulus is 50,000

(Continued on page 13)



The 82-inch reflecting telescope of McDonald Observatory, on Mt. Locke in Texas, is housed in the dome pictured on the front cover. Note the counterweight close to the northern pier.



This chart of the southern portion of the heavens, as depicted by Dürer in 1515, and the chart opposite are reproduced from "The Complete Woodcuts of Albrecht Dürer," edited by Willi Kurth. They are the earliest printed star charts.

DÜRER AND EARLY STAR MAPS

BY SAMUEL G. BARTON, *University of Pennsylvania*

THERE IS SO LITTLE in astronomical literature, and until recently elsewhere, about the contribution to astronomy of the celebrated artist Albrecht Dürer, and so much misinformation in that little, that the need for an article on this subject is very real. The bare fact is that two maps of the sky, 17 inches square, one for the northern hemisphere and one for the southern, which bear his name among others, were published in Nuremberg in the year 1515. Dürer's biographer, Thausing, states: "Stabius took advantage of his residence at Nuremberg, and his intercourse with the artists there, to publish his astronomical and geographical tables, which have much more merit than his labored verses, and in which the Emperor was certainly not less interested. For this purpose he had recourse to Dürer, though it is only the larger and more difficult of the woodcuts which can be referred to the latter's own hand."

The maps themselves constitute our chief source of information. I do not recall having ever seen a reproduction of

The northern portion of the heavens, as depicted by Dürer. Dr. Fritz Saxl describes the four corner portraits: "Dürer has depicted the four men as very different characters; Aratus points to his globe as if lecturing. Ptolemy, like 'Melancolia,' has compass in hand, with his look, however, not roaming in the distance, since the Greek zealously solves an astronomical problem by measuring with the compass. If the two Greeks are clothed in fantastic dress, Manilius meets us in ancient costume. His right hand holds a book, and his left he holds over a globe, but he looks aside. He appears to be engaged in conversation with another scientist. The oriental, Sufi, clothed in a turban is remarkable and impressive. The celestial globe rests on his left hand and his right hand lies strangely crude, spread on the globe. The Arabian holds his head inclined and is absorbed in the appearance of the heavens — a picture of real contemplation."

these maps, or of any part thereof, in astronomical literature. Rarely are they mentioned. They are reproduced here from *The Complete Woodcuts of Albrecht Dürer,* edited by Dr. Willi Kurth, published by Foyle in London in 1927. They are to be found on pages 295 and 296 and are known as Bartsch Nos. 151 and 152.

The map of the southern sky contains in the lower left-hand corner the important information, "Joann. Stabius ordinavit-Conradus Heinfogel stellas posuit-Albertus Durer imaginibus circumscripsit"; that is, there was a triple authorship. Stabius, who was professor of astronomy and court astronomer to Emperor Maximilian at Vienna, was responsible for the general arrangement of the maps; Heinfogel, the Nuremberg astronomer, marked the positions of the stars; and Dürer made the definitive drawings of the figures. Also in this corner are the coats of arms of the three authors respectively, Dürer's being that with the open doors.

The lower right-hand corner gives the privilege of publication granted by Maximilian, dated 1515. The upper left-hand corner contains the coat of arms of the Cardinal Archbishop of Salzburg, Matthaeus Lang, and the upper right-hand corner contains the dedication to him. The heading of the maps means, "The Figures of the Southern Sky."

The northern map contained a similar

heading, not shown here: "Imagines Coeli Septentrionales Cum Duodecim Imaginibus Zodiaci," meaning, "The Figures of the Northern Sky Including the Twelve of the Zodiac." In the corners of this map are represented four astronomers, Aratus Cilix, Ptolemeus Aegyptius, M. Mamlius Romanus, and Azophi Arabus. Dr. C. H. F. Peters, in *Publications,* Astronomical Society of the Pacific, 2:134, comments thus: "Remark, also, the head-gear of the four astronomers in the corners! Those of Manilius and of Al Sufi may be all right; but that Ptolemy should have worn a beaver-hat, or Aratus what looks almost like a derby, one cannot well imagine!"

Probably most American astronomers derive such information as they have about these maps from the book, *Star-Names and Their Meanings,* by R. H. Allen, where the indexed references are on pages 28 and 29. There are other references on pages 13, 32, 98, 102, 161, 284, 308, and 329. Allen's chief references are quotations from E. S. Holden, from P. A. S. P. 2:20 and 2:133. I quote here only parts of two sentences: "These constellation-figures of Dürer, with but few changes, have been copied by Bayer in his *Uranometria* (A. D. 1603); by Flamsteed in *Atlas Coelestis* (1729); by Argelander in *Uranometria Nova* (1843), and by Heis in *Atlas Coelestis Novus* (1872), and have thus become classic. It is a matter of congratulation that designs which are destined to be so permanent should have come down to us from the hands of so consummate a master."

Allen, on his own behalf, writes on page 329: "Dürer drew him [Perseus] thus, but added a flowing robe, a figuring that Bayer, Argelander, and Heis have followed, as they have, in the main, all of that great artist's constellation figures."

Each of these four map makers remarks on the source of his constellation figures. Bayer himself makes no mention of Dürer, although the subsequent map makers refer to Bayer, some at considerable length. It was clearly Holden's statement, via Allen, which caused J. G. Porter to place on the title page of his book, *The Stars in Song and Legend,* the words: "with illustrations from the drawings of Albrecht Dürer." We will discuss references to Bayer later, but at this point let us see what the various map makers have to say with regard to the source of their work.

Flamsteed's name, it should be noted, is omitted from Allen's list of the followers of Dürer. On the first page of Flamsteed's *Atlas Coelestis,* published posthumously, we are told that therein "the ancient figures are restored" and that, "he set himself to form maps of the constellations, in which he found it necessary wholly to depart from Bayer, of whom Hevelius himself complained, without mentioning any particulars." Flamsteed discusses the errors in detail, and makes no mention of Dürer. (A number of constellation figures from Flamsteed's atlas will be found in *Splendour of the Heavens,* pages 647 and following. The figures in the atlas were drawn by Sir J. Thornhill.)

Argelander writes regarding his atlas: "The figures, from Bayer's *Uranometria* for the older constellations and from the *Firmamentum Sobiescianum* of Hevelius for the more recent ones, have been drawn by my assistant, Herr Kysaus."

Heis says of his work, *Atlas Coelestis Novus*: "In representing the constellations it was my main idea, to restore the ancient constellation figures employed by Ptolemy and his predecessors, as was also carried out by the illustrious Flamsteed. Wherefore I decided to adopt as well as possible the figures of my charts to those figures which are shown on the famous marble globe borne on the shoulder of the great Atlas, who, as being the most distinguished representative of Greek art, is known as the Farnese Atlas, and whom it was my good fortune to marvel at in the Royal Neapolitan Museum in 1868."

Here then we find among the most famous map makers complete absence of any reference to the maps of 1515 or to Dürer.

We may now turn to a consideration of the various representations of the constellation figures themselves. Quoting Dr. Peters again, P. A. S. P. 2:133: "compare on these maps [Dürer's] Cetus or Piscis australis, Gemini, Boötes, Hercules, which are quite original with Dürer, with modern drawings. Centaurus cum Lupo resembles the drawing in Sufi, and that upon the Arabic globes somewhat. Andromeda has, with Dürer, a rather awkward position. In the *Progymnasmata* of Tycho Brahe we find a drawing of Cassiopeia that resembles Dürer's. The general and principal difference between Dürer's and the modern figures consists in this; that the former represents the figures as seen on the outer surface of the globe — that is, with their backs toward us. Queer contortions of the head thus originated, as, for example, in Orion, Perseus and Auriga (Erichthonius), the latter almost incredible and not worthy of a Dürer."

In the Porter book, already mentioned, which credits its illustrations to drawings of Dürer, the figures are simply Bayer's with slight modifications. Compare them with those of Dürer, now before you, and you will be able to decide easily the extent to which Bayer copied Dürer. Also some of Bayer's figures are reproduced in Shapley and Howarth, *Source Book in Astronomy,* pages 20 and following.

If one compares, however, Bayer's figure of Orion on page 24 with that given on page 27, he may well ask which is to be accepted as the correct one. In the latter he has head-gear, carries a shield, and faces Taurus, and differs in other respects from the Orion on page 24. On the drawing of the zodiacal constellations (page 27) Cancer is represented as a lobster whereas in Bayer's separate drawing it is a crab. Attention is also called to differences in Aquarius, Ara, Cetus, Crater, Ophiuchus (Serpentarius), and Piscis Austrinus (Notius).

In modified form Bayer's figures are found in a number of other places, but charts which are white on black, or which lack the Greek letters — the most important feature, historically, of Bayer's drawings — with English titles, special star names, and so on, are not reproductions of Bayer's figures and should not be so labeled. With these warnings, however, some of these so-called reproductions may be useful for comparisons.

Flamsteed refers specifically to the Bayer figures: "Bayer's figures are tolerable . . . but having drawn all human figures except Boötes, Andromeda, and Virgo with their backs toward us, those stars which all before him place in right shoulders, sides, hands, legs or feet fall in the left."

B. A. Gould, in his *Uranometria Argentina,* 1879, page 50, writes of Bayer: "The simple and important advance, of so delineating the constellations as to permit the maps to be compared directly with the face of the sky, rather than with a fictitious outer surface of the imaginary celestial sphere, would seem to be such as to commend itself to the favor of all astronomers; yet such was not the case. It necessarily implied a reversion of some of the figures, thus interchanging right and left; and this gave rise, not only to the vehement opposition of Bartsch, Schickard, and others, but even of those great observers, Hevel and Flamsteed. The last-named astronomer attributed the inversion to a misinterpretation of Ptolemy's phraseology, and in a philological dissertation disproved the supposed error."

One may well ask how the constellation figures should be drawn. The authors do not agree; some of the arguments presented are not convincing, particularly Gould's. I do not surely know, for example, whether Orion should be drawn right-handed or left-handed, or whether or not he should face Taurus, but this is not the place to discuss these points. There seems to be about as much need for a standard for the constellation figures as there was for the names, boundaries, and pronunciations, although, of course, the matter is less important.

Considering the absence, in all the foregoing, of any reference to the maps of 1515 or to Dürer, and the lack of similarity in the constellation figures, I must conclude that Dürer's influence upon the map makers who followed him in point of time was slight indeed. Only Peter Apian's map of 1536 closely resembles Dürer's work. This map we will discuss, along with some preceding Dürer, in the second portion of this article. *(To be concluded)*

NEWS NOTES

By Dorrit Hoffleit

THE NEW ASTRONOMISCHE GESELLSCHAFT

Dr. A. N. Vyssotsky, of the McCormick Observatory, transmits news on German astronomical activities communicated to him by Dr. J. Larink, of the Hamburg-Bergedorf Observatory. In the British zone of Germany, with the permission of military authority, a new Astronomische Gesellschaft has been organized with a constitution practically the same as that of the prewar AG, which "died" in Berlin. Membership is unlimited except that the officers of the society must reside in the British zone.

Several important German astronomical publications are to be continued or resumed. The *Astronomische Nachrichten* is to be financed by the Deutsche Akademie and edited by Kienle and Wempe in Potsdam. The *Zeitschrift fuer Astrophysik* will be published by Springer (publishers) in Heidelberg under the editorship of Grotrian of Potsdam and Unsöld at Kiel. These publications correspond closely to our professional organs, the *Astronomical Journal* and the *Astrophysical Journal*. *Himmelswelt,* which is more in the nature of *Popular Astronomy,* will be published by Duemmler (edited by Unsöld, W. Becker, Strassl, and Wellmann) as the official organ of the AG.

Dr. Larink writes: "There are many and very serious difficulties to be overcome if these few objectives are to be reached. The worst one is the shortage of paper. However, we intend to exert our efforts in order to promote the development of astronomy."

HELIUM IN METEORITES

Assuming that the helium contents of meteorites are affected only by the radioactive decay of uranium and thorium, the relative abundances of these elements have in the past been used for estimating the ages of meteorites. In a current note to the *Physical Review,* Carl A. Bauer, of Harvard College Observatory, questions the infallibility of such estimates and offers a new interpretation for the observed relative abundances of helium. He notes: "The large helium contents appear only in the relatively small masses or, conversely, all of the large meteorites show relatively small helium contents."

Pointing out that cosmic rays produce nuclear disruptions in which alpha particles (helium nuclei) are among the disintegration products, Mr. Bauer calls upon cosmic radiation to account for the meteorite observations. "In traversing the atmosphere large meteoroids maintain their high cosmic velocities for a longer time and thus lose a thicker layer of material by evaporation than do small meteoroids." Since the cosmic-ray bombardment of meteors in space would affect the surface layers most, the relatively higher helium content in originally smaller bodies would be reasonable.

Thus, previous estimates of meteorite ages would have to be discounted, for "the largest observed helium content can be produced in a small meteoroid by cosmic radiation in a time less than the present assigned age."

AN INTERNATIONAL COMPETITION

With their aim to develop and extend the use of photography as a basic research tool, the Smithsonian Institution and the *Scientific Monthly* are jointly sponsoring an international competition, "Photography in Science." An exhibit will be designed to bring together the various techniques of photography used in all fields of science, and awards are to be made on the basis of originality, initiative, and the results obtained through photography rather than merely on composition and pleasing pictorial effects. Scientists everywhere are eligible to compete, as long as they are actively engaged in scientific research or teaching, private practice or consulting.

The competition is planned as an annual salon to coincide with the annual meeting of the American Association for the Advancement of Science. Entries for the first exhibit will be received in Washington between September 25th and October 15th, with those accepted to be hung in the Smithsonian Institution during November and in Chicago at the International Science Exhibition of the AAAS, December 26th to 31st. Prints winning awards will be published in the *Scientific Monthly* for January, 1948. For complete information and rules, write to Dr. Frank L. Campbell, editor, *Scientific Monthly,* 1515 Massachusetts Ave., Washington 5, D. C.

TEMPERATURE OF THE OZONE LAYER

The spectra of celestial bodies are affected by the ozone absorption in the earth's atmosphere. Dr. Arthur Adel, of the McMath-Hulbert Observatory, in a brief note in the *Astrophysical Journal,* describes a method for determining the temperature of the ozone layer by means of a comparison of infrared emission spectra of the moon, the earth, and the atmosphere. The degree to which apparent lunar spectra are affected by terrestrial ozone depends on the temperature of the ozone layer.

Dr. Adel states that his method "is essentially one of measuring *relative* intensities at a *single* wave length with a *thermocouple,* and it possesses all the advantages inherent in such a technique." He used spectra he had obtained at Flagstaff in 1941, and despite their very low dispersion obtained surprisingly good values of the ozone-layer temperature: — 44° C. on September 5, 1941, and −53° on November 3, 1941. His method is applicable to other atmospheric layers, H_2O, N_2O, and CO_2, as well as to the ozone (O_3).

METEOR SHOWER FOUND BY RADAR

Last October's spectacular shower of meteors associated with Comet Giacobini-Zinner enabled numerous radar investigators to demonstrate conclusively the value of radar in meteor-frequency studies. This relatively new method for meteor observing is not hampered by cloudy skies or bright moonlight — indeed, it is as applicable in daytime as after dark.

Now Dr. A. C. B. Lovell, director of radar research on meteors at Manchester University, England, announces in a *Circular* of the British Astronomical Association the discovery of a new meteor shower occurring in daylight. Using a radiation beam about six degrees wide, Dr. Lovell and his associates investigated the known active showers during the fall and winter, finding them substantially as determined by visual observations. For the Eta Aquarid shower, however, which began on May 1st this year, it became obvious that "the meteor stream visible to astronomers was merely the beginning of an extremely active belt stretching towards the Sun."

The main radiant point of the stream was found to be in Pisces, with its meridian passage occurring an hour or two before noon each day, so the shower could not be seen at night. Even after the Aquarius end of the belt of meteor activity became inactive in mid-May, as expected, "the Piscid radiant continued with undiminished and extraordinary intensity." It had continued for 53 days by June 22nd, and showed no signs of ending then. The intensity had fluctuated, but the hourly rate of "echoes" ranged from 20 to above 80.

The relative intensity of the new daytime meteor shower is indicated by comparison with the December, 1946, Geminids, which gave maximum hourly rates for successive nights of only 12, 25, 25, 43, 20, 7, with the same observing apparatus. The approximate positions of the new radiant (as determined by a method devised by J. A. Clegg, unpublished) are given as R. A. 20°, Dec. +20° to 25°, on May 7th; R. A. 70°, Dec. +20° to 25°, on June 22nd.

Amateur Astronomers

League's First Regional Convention Is Held at Duluth

BOUNDARIES for a north-central region of the Amateur Astronomers League have been tentatively set to include the states of Kansas, Missouri, Nebraska, Iowa, Minnesota, the Dakotas, Illinois, and Wisconsin, according to a letter from Neil Lockwood, of the Darling Observatory, State Teachers College, Duluth, Minn., where the first convention of this region of the league is being held on the weekend beginning August 29th. These tentative boundaries may be changed to include the northern peninsula of Michigan or other states bounding those named.

The Darling Astronomy Club, which has its headquarters at the Darling Observatory, is the host society for the convention. On Friday evening, August 29th, there is scheduled open house at the Darling Observatory. On Saturday, in addition to the regular business of organizing the work of the league within the region, discussions of amateur activities are planned, and there will be exhibits of the work of amateur instrument makers and others.

Anyone interested in astronomy, whether or not a league member or resident of the states in the region, is invited to the convention at Duluth. Barkley Schroeder, c/o Duluth Chamber of Commerce, or Mr. Lockwood, Physics Department, State Teachers College, can give further information to those interested.

Attendance at the Philadelphia convention of amateur astronomers numbered about 200, although the registration records contain 182 names. Persons registered from 17 states and the District of Columbia, as follows:

California, 1; Connecticut, 3; Delaware, 1; Florida, 2; Indiana, 4; Illinois, 1; Kentucky, 5; Maryland, 5; Massachusetts, 4; Michigan, 11; Mississippi, 1; New Jersey, 19; New York, 47; Pennsylvania, 52; Ohio, 2; Virginia, 8; Wisconsin, 3; Washington, D. C., 13.

On July 6th, the last day of the convention, the Junior Astronomy Club, of New York City, by action of its president, Edward Epstein, became the first organization to join the Amateur Astronomers League under the new rules for junior membership established by the national council at Philadelphia. All junior groups interested in receiving copies of the new rules may write James B. Rothschild, executive secretary, AAL, Science Service Building, 1719 N St. N. W., Washington 6, D.C.

THIS MONTH'S MEETINGS

Chicago: At the regular meeting of the Burnham Astronomical Society on September 9th, an astronomical motion picture, "Looking Through Great Telescopes," will be presented by Dr. O. J. Lee, of Dearborn Observatory. The meeting is at the Chicago Academy of Sciences auditorium.

Members will attend the meetings of the American Astronomical Society on September 4th and 5th, to be held in Room 6 of the Technological Building, Northwestern University.

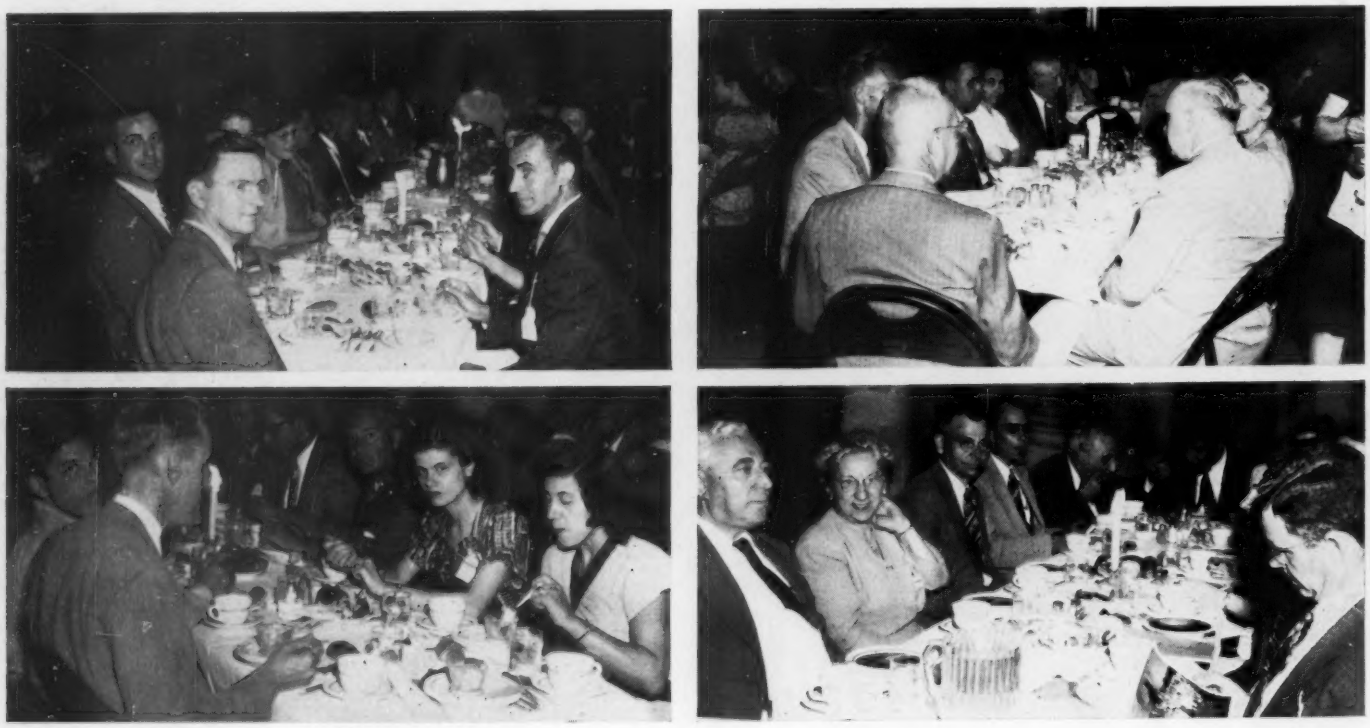
Cincinnati: Dr. Paul Herget, Cincinnati Observatory, will speak to the Cincinnati Astronomical Association on September 12th on "The Moons of Jupiter." The meeting is on the University of Cincinnati campus.

Indianapolis: Meeting at the Johnson Observatory on September 7th, the Indiana Astronomical Society will have an opportunity for "Checking Messier."

Kalamazoo: A potluck dinner at Wolfe Lake, 12 miles west on Route M-43, is scheduled for the Kalamazoo Amateur Astronomy Association on September 13th. The history of the association will be given by Edgar Pashby; pictures will be shown; and there will be observing if weather permits.

Pittsburgh: Dr. A. J. Allen, of the physics department of the University of Pittsburgh, will give a demonstration of how a cyclotron operates, for the Amateur Astronomers Association on September 12th. The meeting will be held at the university, in the Oakland district, and begins at 8:00 p.m. Those who attend will be conducted on an inspection trip of the university's own cyclotron.

Washington, D.C.: Dr. Irvine C. Gardner, of the National Bureau of Standards, will be the speaker at the regular monthly meeting of the National Capital Astronomers on Saturday, September 6th, at 8:00 p.m. in the National Museum. The subject of his talk will be "Telescopes."



Scenes at the banquet in Franklin Hall on July 5, 1947, at the fifth national convention of amateur astronomers, held at the Franklin Institute, Philadelphia, Pa. Photos by R. W. Sanderlin.

Western Editors Meet

Three well-known amateur astronomers, each an editor of an astronomical bulletin, recently met and exchanged views at the June meeting of the Pacific Coast Division of the AAAS at San Diego, Cal. This was also a meeting of the Astronomical Society of the Pacific and the Meteoritical Society.

The editors were Oscar E. Monnig, of Fort Worth, Tex., editor and publisher of the *Texas Observers' Bulletin;* G. Bruce Blair, of the Astronomical Society of Nevada, Reno, editor of *Astronomical Information Sheets;* and Walter H. Haas, of the Institute of Meteoritics, Albuquerque, N. M., editor of the recently established *The Strolling Astronomer,* publication of the Association of Lunar and Planetary Observers.

The several amateur astronomical societies in San Diego met jointly on the evening of June 19th, under the chairmanship of Rudolph M. Lippert, and heard informal talks by the visiting astronomers. Professor Blair spoke on comets, Dr. Haas on lunar and planetary observing, and Mr. Monnig on fireball investigations.

Philanthropist Dies

Science in general, including astronomy, has lost a good friend with the passing of Julius Stone, age 91, formerly of Columbus, Ohio. A manufacturer of fire-fighting equipment, he had a versatile and keen interest in scientific and cultural matters. He was a patron of the AAVSO. Thanks to him, the McMath-Hulbert Observatory possesses one of the world's finest spectroheliographs for studying radial velocities of solar prominences. To Ohio State University he gave its cyclotron, and to Harvard a spectrograph.

Having once lived in Leadville, Colo., Julius Stone became acquainted with Dr. Donald H. Menzel, astrophysicist at Harvard and Leadville native, and this association led Mr. Stone to aid in the development of the coronagraph station at Climax.

Eastbay Honors Chabot Observatory Director

George D. Baird, member of the Eastbay Astronomical Association, Oakland, Cal., describes a supper held at Chabot Observatory on June 21st in honor of Professor Earle G. Linsley, whose retirement as director of the observatory took effect on July 1st. Among those attending the supper and swarming into the observatory building "as though they belonged there" were members who had been coming to Chabot for 25 years.

A committee was in charge of arranging the provender brought by the members "cafeteria style" while the others awaited the time to eat. Afterward, Professor Linsley gave the history of Chabot Observatory, including details of how its founder had given 10 thousand dollars to purchase "the largest telescope in the world, open to the public."

Apparently, the retirement of Professor Linsley leaves the fate of the observatory at stake. Mr. Baird writes, "For some reason, not entirely understood, the council of the City of Oakland hesitates over whether to continue to support the observatory. No one knows how the question will be decided."

IN FOCUS

(Continued from page 2)

by Galileo. It has recently been proven that Mayer did make the prior discovery. On the moon, Marius is a ring plain some 30 miles across, with fairly low walls.

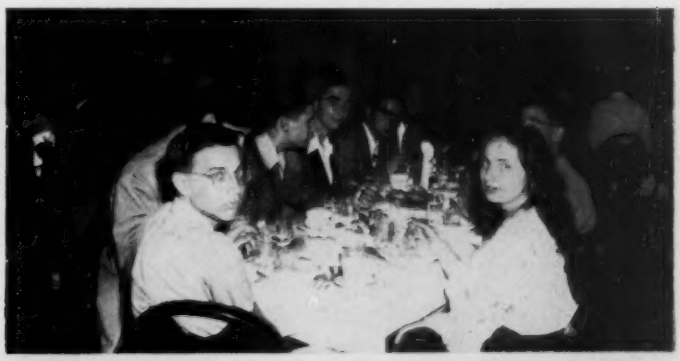
Reiner. A friend and pupil of Galileo, commemorated near him on the moon. Reiner was a mathematician who published astronomical tables, and tables of Jupiter's satellites.

Struve, Otto. Son of Wilhelm, Otto Struve (1819-1905) was also director of Poulkovo Observatory. Of this famous astronomical family, two of Otto's sons were also astronomers, and his grandson, Otto Struve, has been director of Yerkes Observatory since 1921. On the moon, this is a vast ring plain very near the limb, about 160 miles in diameter.

BOUND VOLUMES

of **Sky and Telescope** are now available, for Volumes II, IV, and V, at $6.00 each, plus postage. Binding is in blue library buckram, and the index is bound in each volume. Indexes to all volumes are still in stock, at 35 cents each, in stamps or coin.

SKY PUBLISHING CORPORATION

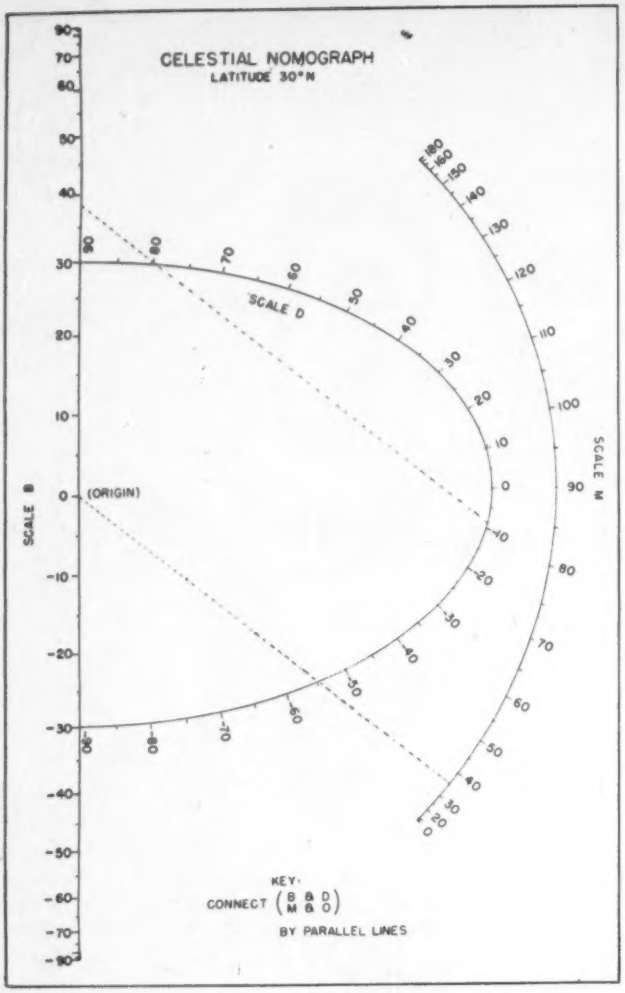


R. W. Sanderlin, who took these pictures of some of the tables at the banquet of the Philadelphia convention, is a member of the Amateur Astronomers Society of Norfolk, Va.

Celestial Nomograph

How to Make and Use It

By Joseph T. Hogan



This celestial nomograph may be used to determine the altitudes and azimuths of stars at latitude 30° north.

"LET'S TAKE A LOOK at the sky!" Is any suggestion more frequently used by amateur astronomers and others interested in the heavenly regions? With a good star map and an improvised theodolite made of a protractor and straightedge, one person or a group of several are prepared to discuss and compare the wonders of the heavens. When we wish to locate a particular star, constellation, or planet, we find ourselves wishing for a rapid means of determining altitude and azimuth. Or perhaps we may wish to determine whether or not a particular celestial body is above our horizon at the time of observation. Spherical trigonometry is the best means of solving our problem, but for rough approximations it becomes cumbersome, and often the observer's evening is spent making lengthy calculations.

The celestial nomograph is a simple device that permits rapid calculation of approximate altitude and azimuth with great facility. Many such charts and diagrams have been published and offered for sale, but often the prepared chart is incomplete or not applicable to the observer's latitude.

The construction of such a nomograph is simple. In preparing this paper, an attempt has been made to furnish a simple means for constructing a celestial nomograph that will fit the amateur's needs and, therefore, be of frequent assistance in the routine calculations. While some readers may never have occasion to make such charts, a knowledge of the mechanics of nomographs should make them more appreciative. To many people, the construction of a celestial nomograph has a fascination comparable to that which the assembling of a jigsaw or the completion of a crossword puzzle has to hobbyists of that type.

The completed nomograph (for latitude 30° north) is shown here. The construction for any latitude differs only in Scale D, as Scales M and B are independent of latitude. Let us consider the operation of the nomograph first, with star Rigel as a specific example.

Application.

The use of the term *hour angle* (h) is here restricted to what may more properly be called meridian angle, that is, it is measured east and west of the meridian to not more than 180°. If the hour angle is east (negative meridian angle), then the azimuth as given by the nomograph is measured *east* of north; if the hour angle is west, the azimuth is in degrees *west* of north. Altitude above the horizon is considered positive, below the horizon, negative.

Parallel rulers are useful in reading nomographs of this type. A substitute used during the war is glass rod of ¼-inch diameter, which may be rolled over the nomograph surface and retain parallelism with its original setting. Care must be exercised to avoid parallax error in reading with such a rod.

To determine altitude and azimuth of a celestial body: *Procedure 1:* Connect hour angle (Scale M) and O (origin); parallel to this line connect another from the declination (Scale D) and read off the altitude on Scale B. *Procedure 2:* Now consider Scale B for declination and connect it to the altitude (determined from Procedure 1) on Scale D. Parallel to this line join O and Scale M, where the azimuth is read off. After a few trials this whole process is done automatically and in a few minutes' time.

Example.

On January 25, 1947, 6:30 p.m. CST, at New Orleans, determine the altitude and azimuth of Rigel (declination −8°.3).

1. The longitude of New Orleans is 90° west of Greenwich. The hour angle of Rigel, computed from the *American Ephemeris and Nautical Almanac*, is 54° west of Greenwich at 6:30 p.m. CST. Therefore, the local hour angle at New Orleans is 90° − 54° = 36° east.

2. Lay a straightedge through 36 on Scale M and the origin O. Sliding the straightedge parallel to this line, pass it through the value −8.3 on Scale D. The straightedge intersects Scale B at 38. Thus, the altitude of Rigel is 38°, as shown by the dotted lines in the diagram.

3. Lay the straightedge through −8.3 on Scale B and 38 on Scale D. Sliding it parallel to this line, pass it through the origin O. The straightedge intersects Scale M at 132. Thus, the azimuth of Rigel is 132° east of north.

Theory and Construction.

A celestial body's position in the heavens may be defined by two elements — altitude and azimuth. *Altitude* is the arc of a vertical circle included between the body and the horizon. *Azimuth* is the arc of the horizon measured from the north point to the foot of the body's vertical circle. These two quantities may be calculated by solving the following equations:

(1)
$$\sin a = \sin l \sin d + \cos l \cos d \cos h$$

(2)
$$\sin d = \sin l \sin a + \cos l \cos a \cos A,$$

where d is the declination of the object observed, h its hour angle, l the latitude of the observer, a the altitude, and A the azimuth of the object.

Equation (1) may be put in the form,

$$\sin l \sin d = -\cos h \ (\cos l \cos d) + \sin a,$$

which is recognized as the slope form of the equation of a straight line,

$$y = mx + b,$$

where $y = \sin l \sin d$, $x = \cos l \cos d$, $m = -\cos h$, and $b = \sin a$.

Suppose an observer at New Orleans (latitude 30° north) wishes to prepare a celestial nomograph for his latitude. The following detailed instructions may be used.

1. The values for d, h, and a are selected for regular intervals. The value of l is 30°.

2. Draw a pair of temporary X-Y axes on a large sheet of rectangular coordinate paper, and, having chosen a unit for x and y to fit the limits of the sheet, substitute the chosen values of d in the following equations:

$$x = \cos 30° \cos d$$
$$y = \sin 30° \sin d$$

A tabulation, such as shown in the table, is helpful in keeping values orderly for plotting.

3. Plot the points (x, y) obtained in Step 2, labeling each point of the curve with the value of d to which it corresponds. Connect these points by a smooth curve, which forms Scale D.

4. Using the values of a for regular intervals, substitute them in the equation:

$$b = \sin a$$

These values are also shown in the accompanying table.

5. Next, using the same unit for y as above, plot along the Y-axis the values of b obtained in Step 4. Label each point with the corresponding value of a. This gives Scale B.

6. Finally, with the origin as center, and any convenient radius, draw a circle cutting the X-axis beyond the point where Scale D intersects it. Substitute the selected values of h (from 0° to 180°) in the equation:

$$m = -\cos h$$

7. Along this circular arc, lay off the angles *whose slopes* (*tangents*) are equal to m, labeling each point of the arc with the value of h to which it applies. This gives Scale M.

8. The last step is to check the scale layout by solving several problems, the answers of which are known. In using this form of chart, two straight lines are required. Thus, in order to determine whether three values, d, h, and a, satisfy the given equation (1) above, lay one straight line through the points a and d on the Scales B and D respectively, and another straight line through the point h on Scale M and the origin O; if these lines are parallel, the three values of d, h, and a satisfy the equation.

9. After the D, B, and M scales are completed, the temporary X-Y axes can be erased. The accuracy of a solution by the chart is dependent on both the accuracy of plotting and alignment. Graduations shown should be no wider than for proper visibility and legibility. They should be so labeled and varied in length that readings can be made at a glance without tedious counting.

The construction of a nomograph for any latitude is similar to the above except that to make Scale D the value of l for a given latitude is substituted in the equations for x and y. Scales M and D are the same for all latitudes, since the value of l does not occur in the equations of their scale. It will be noted that sin a occupies the same position in equation (2) that sin d occupies in equation (1) and similarly sin d occupies in equation (2) the position of sin a. Instead of the expression cos h in equation (2) we have cos A. Thus, our nomograph also serves for the solution of equation (2) if we use Scale B for the declination and Scale D for the altitude. Scale M in this case is used for azimuth.

d	x	y	a	b	h	m
0°	0.866	0.000	0°	0.000	0°	−1.000
10	.853	.087	10	.174	10	−.985
20	.814	.171	20	.342	20	−.940
30	.750	.250	30	.500	30	−.866
40	.668	.322	40	.643	40	−.766
50	.556	.383	50	.766	50	−.643
60	.433	.433	60	.866	60	−.500
70	.296	.470	70	.940	70	−.343
80	.150	.492	80	.985	80	−.174
90	.000	.500	90	1.000	90	0.000
−10	.853	−.087	−10	−.174	100	.174
−20	.814	−.171	−20	−.342	110	.342
−30	.750	−.250	−30	−.500	120	.500
−40	.668	−.322	−40	−.643	130	.643
−50	.556	−.383	−50	−.766	140	.766
−60	.433	−.433	−60	−.866	150	.866
−70	.296	−.470	−70	−.940	160	.940
−80	.150	−.492	−80	−.985	170	.985
−90	.000	−.500	−90	−1.000	180	1.000

CURRENT RESEARCH AT YERKES OBSERVATORY

(Continued from page 5)

times brighter to the eye than R Leonis, the latter star is at least 20 times brighter than Regulus when observed with the PbS cell. With this cell, photometric observations of variable stars, especially eclipsing variables, should prove exciting and profitable. However, a fairly large reflecting telescope is needed in order to have a sufficiently high signal-to-noise ratio for accurate observations.

Thus far we have not mentioned any investigations concerning galactic structure. One of the chief programs with the 40-inch refractor is the determination of spectroscopic absolute magnitudes and parallaxes. W. W. Morgan, under whose direction this program is carried out, is at present determining the spectroscopic absolute magnitudes and parallaxes of all northern B stars, together with stars of other types brighter than magnitude 6.5. William Bidelman is working on the spectral classifications of A-type stars near the south galactic pole, the spectral types of the members of the Praesepe open cluster, and the B-type stars in the Double Cluster in Perseus. Other studies concerned with galactic structure are by Dr. Greenstein on the spectrum of the Orion nebula and on the relation between interstellar absorption and reddening.

Thornton L. Page, who has only recently returned to Yerkes from the U. S. Navy, is testing a new grating spectrograph which has a camera with a focal ratio of only 0.6. He plans to investigate the rotation, the spectral energy distribution, and the character of emission features in extragalactic nebulae. This is part of his theoretical and observational program concerning the new cosmological theories of Milne.

In writing this brief resume of the programs at Yerkes and McDonald observatories, it is not possible to give details of all the worthy projects. For example, mention has not been made of Dr. Greenstein's attempts to photograph the spectrum of the sun in the far ultraviolet from V-2 rockets, Dr. Popper's studies of the populations of globular clusters, Dr. Kuiper's work on the spectra of faint proper-motion stars, Dr. Struve's and P. Swings' investigations of the spectra of peculiar stars, L. G. Henyey's (now at the University of California) theoretical studies of radiative equilibrium, and numerous other programs by the Yerkes staff.

HENRY NORRIS RUSSELL RETIRES

On July 1st, Dr. Henry Norris Russell retired from a half-century of service as director of Princeton University Observatory, to be succeeded by Dr. Lyman Spitzer, Jr., formerly professor of astrophysics at Yale University Observatory. Dr. Martin Schwarzschild has also been appointed professor of astronomy at Princeton.

Dr. Russell is continuing his important contributions as an astronomer, however, for he will be a research associate at Harvard Observatory for the year 1947-1948. He also has been appointed a research associate at Lick Observatory.

A Rocket Trip Around T

By Robert R. Coles, *Hayden Planetm*

OUR SPINNING PLANET is an almost ideal vantage point from which to contemplate the universe. Rotating eastward on its axis every 24 hours and revolving around the sun each year, it reveals to man an ever-changing panorama of celestial wonders. But the sky picture that any individual views varies greatly depending on his location on the earth.

Most of us are pretty familiar with the sky from the mid-latitudes of the United States. Indeed, we may be so used to the star patterns and their apparent motions from this point of view that we are likely to become hopelessly confused when we consider the heavens from some far southern latitude or from one of the poles.

Many people at times wonder what the stars are like beyond our horizons. What fun it would be to hop on a magic carpet or one of those ultra-modern rocket ships and fly around the world!

The details we will leave to those rocket enthusiasts who delight in such problems. We shall not concern ourselves here with the design of the ship, the type of fuel, pay load, or any of the other matters so vital in such an undertaking. After all, ours is going to be a purely imaginary journey and we shall travel at an imaginary speed.

As a convenient skyway we'll choose the celestial meridian over the geographical meridian of 75° west longitude, and we shall embark from the point where that great circle crosses the 40th parallel of latitude north of the equator. This happens to be in the state of New Jersey, not far from the city of Philadelphia.

The hour and season will, of course, determine what stars we shall see before taking off. Regardless of season, however, there is a region of circumpolar stars in the north. These are located within a circle with its center (the north celestial pole) elevated 40° above the northern horizon. And about one degree from that pivot in the sky is Polaris, the North Star. The Big and Little Dippers, Cassiopeia, Cepheus, and Draco are found within this circumpolar region, which turns like a great celestial wheel in a counterclockwise direction about the north celestial pole. Except for a few stars near the perimeter of the wheel which may be hidden for a time by buildings, hills, or trees on the northern skyline, these stars are visible throughout every clear night of the year.

In addition to the circumpolar stars there are many others that, from our rocket take-off point, can be seen part of the year but not throughout the entire 12 months. Some of these are above the horizon longer than they are below. The brilliant suns Arcturus and Vega are among these. Others, such as Sirius and Antares, are below the horizon for a longer time than they are above. From this location we may see all of the constellations of the zodiac in much less than a year of watching.

We see also, from our study of sky charts and celestial globes, that there is a region of stars below the southern horizon (equal in area to the circumpolar region of the north) that never rises in this latitude. These we can never see unless we journey south.

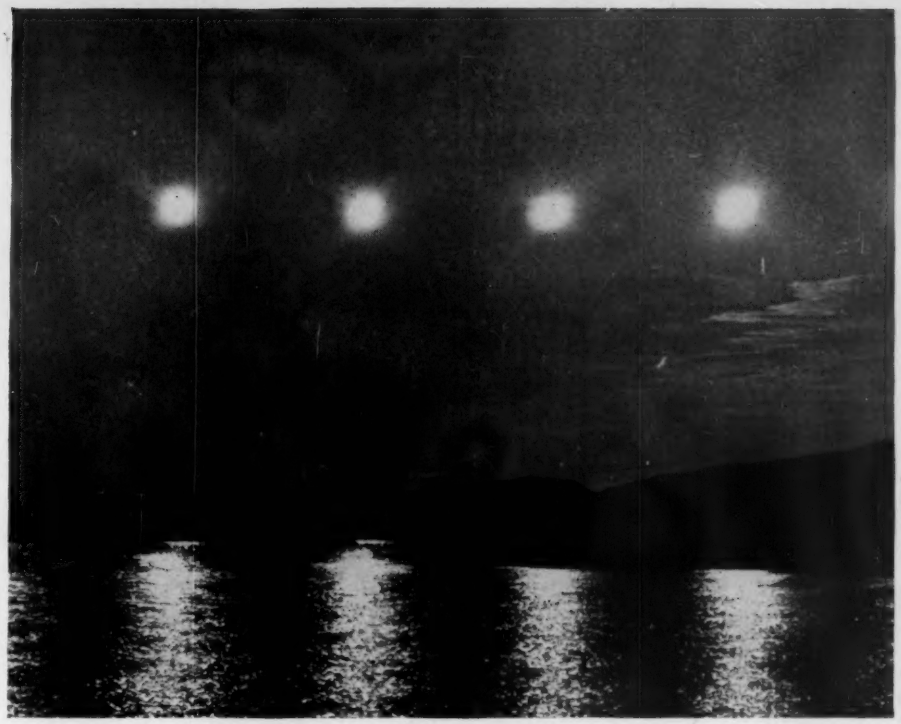
We shall wait until December 20th, when the sun has dipped almost to its farthest below the north pole horizon, before embarking on our journey. As we all know, it would be useless to look for stars at the north pole during that half of the year between March 21st and September 23rd, when the sun is always in the sky. And even after sunset at the pole on September 23rd, there are several weeks of twilight before it becomes dark enough to see any but the brightest stars.

Before setting out let's have a look at the sky. It is about 8 p.m., December 20th. (This corresponds to 2 a.m., September 20th, as far as the sky position is concerned.) The winter constellations are climbing prominently into view in the eastern sky. Orion appears high in the southeast. Sirius is just visible above the southeastern skyline. In the northwest the famous Northern Cross stands bolt upright above the horizon.

Across the southern sky from the southeast, where the brilliant Sirius sparkles like a diamond, are the constellations of Lepus, the Hare; Eridanus, the River;

A phenomenon of the tropics: the zodiacal light. Drawing by Trouvelot.

THE WORLD



A phenomenon of the arctic and antarctic regions: the midnight sun. Photograph by Donald B. MacMillan, at Etah, Greenland.

Cetus, the Whale; and Aquarius, the Water Carrier. It will be well to remember these southern constellations for we shall look for them later when we have arrived at the north pole.

In the north, the Big Dipper is standing on its handle east of the meridian, and high in the north, directly across the pole from the Big Dipper, rides Cassiopeia.

Having familiarized ourselves with this typical evening sky of late autumn or early winter, let us strike out along our skyway to the north. Such an imaginary journey as this is entirely possible in a projection planetarium, where the visitor travels at a speed of 5,000 miles a minute, fast enough to carry him all the way around the world in about five minutes.

At about 8 p.m., December 20th, we take off and fly a true northerly course. Immediately we see the stars apparently streaming southward. In no time at all we have arrived at 50° N. and we notice that Sirius has disappeared below the horizon. If we were to stop here and wait a few moments, it would rise again as the earth's rotation carried it out beyond the skyline, but we have no time to wait.

In the northern sky, the stars are rising from beyond the curved edge of the earth. The North Star climbs one degree higher for every degree of latitude we push northward. The area of circumpolar stars grows larger and larger as we advance. The whole sky picture changes rapidly. As familiar stars and constellations disappear in the south others climb into view before us. It is a most amazing experience, as if the earth were rotating on an axis through the equator.

The North Star continues its march up the sky until it hangs almost directly overhead and about that time our navigator tells us that the north celestial pole is in our zenith. We have reached the north pole. We linger here for several hours before continuing our journey down into the Eastern Hemisphere, so that night will shroud that part of the earth as we travel.

This is a new and different perspective! The stars that circled counterclockwise over the northern horizon at the beginning of our journey are now high overhead. In fact, there is no more north, nor east, nor west. Here at the top of the world all directions are south. The entire dome of the sky wheels about us counterclockwise on a pivot that is directly at the zenith. Every star makes a complete circuit of the horizon, returning to its starting point in 24 sidereal hours. All stars move in circles parallel to the horizon and none sets.

When we look for Orion it first seems to be lost, but we finally locate Betelgeuse and Bellatrix quite low on the horizon. Orion's belt and sword and the stars in his legs are below the horizon. Here at the north pole we see just half of the celestial sphere. Sirius can never be seen from the north pole for this reason. And those constellations that we noticed across the southern sky before we took off (Lepus, Eridanus, Cetus, and Aquarius) also never are seen from the north pole. While it is possible to see all the zodiacal constellations in a few months from the mid-latitudes, only six of them (those north of the celestial equator) can ever be observed from the north pole. Here the moon is above the horizon for about two weeks and below for an equal time.

When we eventually leave the north pole and head down the meridian of 105° E., the cardinal points again become significant. Rapidly the North Star begins descending and the stars ahead, to the south, start climbing the sky. As it is about 12 hours since we first embarked we encounter the same star patterns ahead that we left behind on our journey north, and at 40° N. we observe the same sky picture that hung above us

(Continued on page 17)

A phenomenon of all latitudes: the aurora. It is common in polar regions, frequent in temperate zones, and rare in the tropics.

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BOOKS AND THE SKY

MAKING YOUR OWN TELESCOPE

Allyn J. Thompson. Sky Publishing Corporation, Cambridge, 1947. 211 pages. $3.50.

THE FIELD covered by this welcome volume is confined to building a reflecting telescope; while the refractor is mentioned briefly in the opening chapter, it is not further considered.

It is not assumed that this book will completely supplant all others of its kind, but we predict that it will find great favor with beginners who want their information in a logical sequence, well illustrated and diagramed. The author blazes a clean, straight path through the maze of information and outmoded practices, carrying his student through the comparatively simple grinding and polishing operations, the intricacies of arriving at a spherical mirror, altering it to the delicate paraboloid, then showing him how to mount the telescope simply but adequately with easily procured pipe-fitting mountings, with or without machine work.

The practical end of telescope making is well covered in all its phases, and the author introduces some simplified methods of working which should greatly encourage the novice and assure him of eventual success. This clarity of information and direct suggestion of methods of accomplishing all steps in the project will find disfavor with the die-hard experimenters, but the book is not intended for them. The beginner doesn't feel like making private investigations in the field of optical work, but wants to build a telescope in the easiest and most economical manner possible.

The opening chapter, "Story of the Telescope," contains much of a historical nature, among other things telling how Herschel used powers up to 7,000 magnification on his 6½-inch reflector, and describing the eyepiece used. To counteract any erroneous impression the beginner may get from such reading, Chapter XIII, "Optical Principles, Atmosphere, and Magnitudes," brings him right back to earth with the warning that a power of 300 or thereabouts will show him all that a 6-inch mirror is ever intended to reveal. This latter chapter is, incidentally, among the most interesting in the book once the amateur has finished his telescope and begins using it. Averted vision, diffraction, resolving power, tube ventilation and insulation are discussed, as well as aberrations of the paraboloid.

Indicating the importance of the diagonal mirror, Chapter VII takes 21 pages to cover this subject thoroughly. Quite as extensive is the treatment of the mounting. Even though the beginner may live in a rural section, if he wishes to avail himself of the convenience of pipe fittings for a mounting, complete lists of materials for making three different mountings are available, together with drawings of the parts and the way they fit together. One should have no difficulty ordering the various parts by mail if he were unable to shop for them personally.

The author's style is not pedantic, and his sympathetic outlook is manifest in the last chapter, where he recognizes the almost inevitable desire to build another telescope almost before the first has been completed. The relative merits and the difficulties encountered in making short- or long-focus instruments are discussed.

An appendix humorously entitled "Secondary Reflections" tells among other things what to do if you break either the mirror or tool blank before completion. Curiously, the caliber to use if the mirror is broken **after** completion is not indicated. Under "Concrete Suggestions" in this appendix we are given the proportions of sand, cement, and gravel to be used in the foundation of the telescope, usually a matter of guesswork with the average amateur. Nothing is left to chance! The second appendix describes the three-disk method for making an optical flat, so useful to the

NEW BOOKS RECEIVED

JOHN COUCH ADAMS and the Discovery of Neptune, *Sir Harold Spencer Jones,* 1947, *Cambridge University Press, Macmillan.* 43 pages. 75 cents, paper bound.

The English Astronomer Royal reviews the ever-fascinating story of the discovery of Neptune, discussing the parts played by both Adams and Leverrier. A number of pertinent quotations from contemporary writings are cited, and there are two interesting manuscripts reproduced in part — one, the memorandum by Adams to investigate the irregularities in the motion of Uranus, and the other the paper by Adams summarizing his results which he left at the Greenwich Observatory for Airy's attention.

William T. Skilling
San Diego State College
Robert S. Richardson
Mount Wilson Observatory

Astronomy

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- **Photographs of the great sunspot of 1946**

These are a few features of the thorough revision of this popular text. Augmented by new star maps, an enlarged table of chemical elements in the sun, and other 1947 data on sunspots and eclipses, this new edition has been in large part rewritten to include important present-day research. It will be valuable as a text for students and the many original reference tables will be useful to working astronomers. The lucid style is particularly evident in the material on astrophysics and spectroscopy.

692 pp (8 pp of star maps) *late August 1947*
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amateur optician, while Appendix C lists desirable books and publications on optics and telescope making, general astronomy, and observing.

Throughout the book there are interesting and informative footnotes on matters astronomical and definitions of optical terms. A very complete index covers the text, beginning with **Aberration, chromatic,** and ending with **Zone, defined.**

It's not a book I'd want to take to a desert island, because with lots of sand for abrasive I'd probably die of frustration for want of two disks of glass. It is, however, one book which the beginner may confidently purchase as his initiation fee into the brotherhood of ATM, emerging a confirmed glass grinder.

LEO J. SCANLON
Valley View Observatory

A ROCKET TRIP AROUND THE WORLD

(Continued from page 15)

when we took off. But we have no time to linger here. Our rocket ship carries us on to the south where we discover new and unfamiliar constellations coming up above the southern horizon. In many ways this leg of our journey is even more revealing than our trip north. Now we are beginning to see many stars that are hidden to observers in the northern and central United States.

We begin to see more of that tenuous, winding thread of dim stars in Eridanus and many more recently named and less familiar southern constellations. Soon Polaris drops so low that it is practically lost to view and almost immediately our navigator informs us that we have arrived at the equator.

Here the celestial equator climbs out of the east, cuts our zenith and descends in the west. In the north we view a sight of strange and unique aspect. Cassiopeia is still visible in the northern sky, riding fairly high and to the west of the meridian. But the Big Dipper has entirely disappeared as has the Northern Cross. Taurus, the Bull, appears upside down in the northeast.

From the equator there are no circumpolar stars. The sun and stars are above the horizon for 12 hours and below for an equal length of time. Day and night are of equal length throughout the year, just as we have equal day and night in our mid-latitudes at the times of the equinoxes. Twilight and dawn are the shortest that they are anywhere on the earth. In theory, at least, it would be possible to see all of the naked-eye stars in the celestial sphere from the equator in a period of a few months.

If we are to continue our journey south to the pole under the stars, it will be necessary to make another delay. We know that the midnight sun is now near its highest in the Antarctic. We must linger until long after sunset at the south pole. Actually we'll wait until about June 21st, when the sun has sunk to its lowest point below the south pole horizon. During the six months' delay we therefore make at the equator there is a complete change in the sky picture. In the north Cassiopeia disappears below the horizon and the Big Dipper climbs plainly into view. Over the southern horizon appear the Southern Cross, Alpha Centauri, our nearest stellar neighbor beyond the sun, and many other interesting stars and constellations, the sight of which is denied most northern dwellers.

When we once more journey southward, the southern stars climb higher and higher until finally we arrive as far south as one can travel. The south celestial pole, which has been steadily climbing the sky before us, now hangs directly overhead. Once again the celestial equator rests on the horizon and the stars turn in circles parallel to that horizon. They move in a clockwise direction, which is directly opposite to the apparent sky motion that we observed from the north pole. Again half of the celestial sphere is poised above us but this time it is the half that is entirely hidden at the north pole. Here we see only the lower half of Orion. Sirius is visible and the half dozen zodiacal constellations that never rise at the north pole are visible. Here all directions are north, and the moon is above the horizon for that half of the lunar month after it has set at the north pole.

Now we are ready to re-enter the Western Hemisphere along the meridian of 75° W. longitude and return to our point of departure. As soon as we leave the south pole the directions north, south, east, and west take on their familiar meaning. The stars again begin streaming southward. The Southern Cross and its other companion constellations in the far southern sky start descending behind us. Finally, we cross the equator and the North Star appears ahead of us. Rapidly it climbs higher and higher until it attains an altitude of about 40 degrees and we know that our trip is over. We have completed a rocket trip around the world.

Sky Publications

Cosmic Rays 50c
Here is the story of the "mysterious and unseen but powerful visitors from space," graphically told, with some background in atomic physics. By W. F. G. Swann, director of the Bartol Research Foundation.

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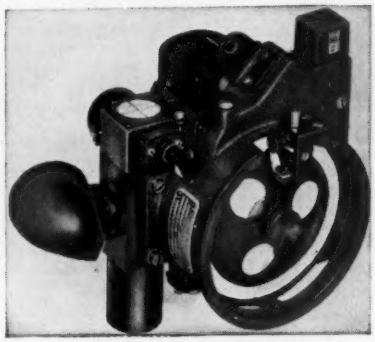

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A DETROIT AMATEUR'S 8-INCH REFLECTOR

JOHN SKART, 2986 Wreford Ave., Detroit 8, Mich., sends us some photographs of his 8-inch f/8 reflector, an obviously well-constructed instrument, which was on exhibit at the amateur astronomers convention at Cranbrook last year (see **Sky and Telescope,** August, 1946, page 4). Mr. Skart has replaced the tripod mount he had at that time with the fork mounting shown here. He writes:

"As far as mirror finish is concerned, L. H. Sprinkle (founder of the Northwest Detroit Astronomical Society) told me, 'This is the fourth mirror in my optical life that I have come across to check that is near perfection.'"

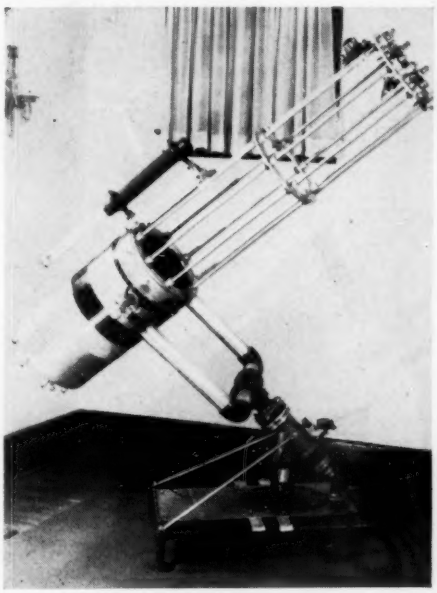

Fig. 1. John Skart's reflector.

Mr. Skart describes his parabolizing technique as follows: "My barrel support was marked into eight spaces at points 45 degrees apart. Starting at the first point I made one-third strokes, then moved on to the next point, repeating the strokes until I had circled the barrel to the first point. The cerium oxide suspended in alcohol and not of dense consistency was in a perfume bottle. A rubber ring on the pipette used to withdraw the cerium oxide solution prevented the pipette from going nearer than one inch to the bottom of the bottle. The pipette contained enough solution to last for the complete circle during wet weather.

"After two hours I checked and — alas — I found that I had my doughnut already. I could not believe it but experts, the following day, assured me that the mirror was near perfect. Of course, the spherical surface before parabolizing was as near perfect as I could get it, and cleanliness throughout was near the border of insanity."

Mr. Skart built a Foucault testing machine with precision measuring instruments attached for his testing. We can only conclude that the word "alas" above results from his chagrin at having built an elaborate instrument and having so little occasion to make use of it.

Fig. 1 shows the over-all construction of the telescope. Note the one-inch diameter brass plugs which form the declination axes. These slide in tees mounted at the ends of the fork and are easily pulled out to permit demounting of the tube from the fork. The fork is attached to the base by means of three ⅜-inch bolts, which are easily removed — thus the instrument may be broken down into three major parts within a few minutes.

Fig. 2 is a closeup of the base. The compass is a novel idea to facilitate setting the telescope in position. It is evidently

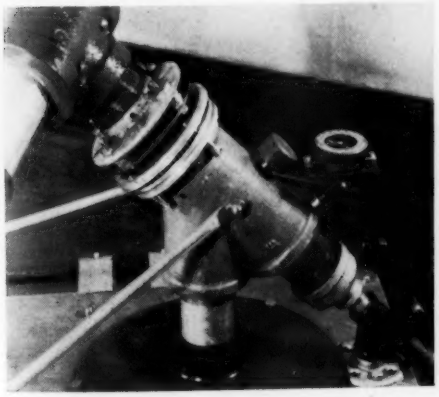

Fig. 2. Base and mounting.

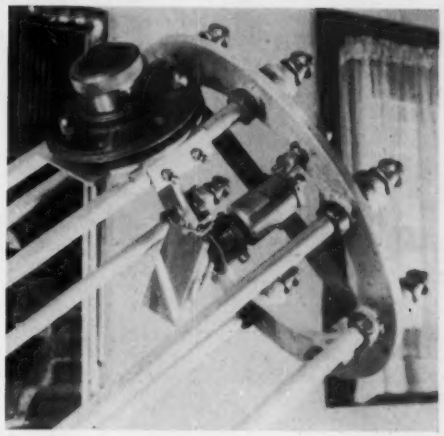

Fig. 3. Upper end of the tube.

equipped with self-luminous numerals and needle.

Fig. 3 shows a closeup of the upper end of the tube, and indicates the method of fastening the tube rails to the end ring with electrical conduit couplings. The diagonal support is also clearly shown. Mr. Skart advises that he has replaced the rectangular flat with an elliptical one since these photographs were taken.

The lower end of the tube is shown in Fig. 4, where details of the mirror support are visible. The ends of the tube rails are also visible here. These rails, best seen in Fig. 1, are made of aluminum tubing ½

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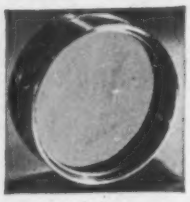


3" Achromatic Lens

Harry Ross Series of "Doublestar" Refractors, 3" aperture (75mm), 40" focal length (1000mm). An air spaced lens, strain free mounted in a smooth aluminum finished satin-black barrel. This lens is an exclusive Harry Ross product. It has a money back guarantee which states, "This lens will meet any and every test you may devise for it as an astronomical objective." It is 20 years since a lens of this quality has been available. Our production is limited. Order early. Postpaid $60.00.

Achromatic Telescope Objectives in all sizes up to 6" diameter to order. Same optical guarantee as with our 3" lens. Write us.

Focusing Mechanism

For Standard 1¼" Eyepiece

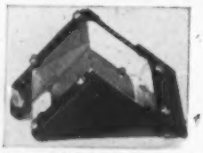
Full 2" of focusing motion. One revolution of knurled knob produces ¼" motion on optical axis. Absolute centering guaranteed. No play. Will not bind or lock. No rack and pinion to strip. Precision turned ways allow smooth, easy positive focusing. Adapted to every type of telescope construction. Highest precision, perfect workmanship. Of brass and bronze throughout. Weight 1¼ lbs. $32.50.

FOR REFLECTORS — Concave flanged bushing can be supplied to fit the size of your tube. Give telescope tube diameter when ordering. Bushing extra $10.00.

Double Achromatic Lens System

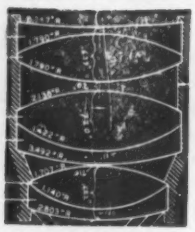
All outside surfaces fluoride coated. 2½" (64 mm) f.l., mounting O. D. 1-3/16" (30 mm), clear aperture ¾" (23 mm). Suitable for inverter with our eyepiece; as an excellent corrected magnifier (4 power) and as a projection lens for 2x2" slides. Each $3.50.

Prism—Light Flint Glass



Fluoride coated, in mounting of aluminum-magnesium alloy, with ballbearing swivel. Meets most exacting requirements. 1-5/16" by 1¼" face. Suitable as diagonal for reflectors up to 8", also as star diagonal on refractors. These prisms can be used to make Porro's system No. 2 erector. Price $3.75.

3-Element Achromatic Eyepiece



Six lenses! Finest eyepiece ever made anywhere. Our greatest buy to date. Made of three separate achromatic elements (illustrated). All outside surfaces fluoride coated. In focusing mount. 1 13/16" (43mm.) clear aperture, flat field to edges. Focal length 1¼" (32mm.) (8X). 69° angle. Outside diameter of mount 2⅛" (54mm.) Each $15.00 plus postage. Quantity definitely limited. Lenses only for above, $9.00 per set.

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Scientific and Laboratory Apparatus

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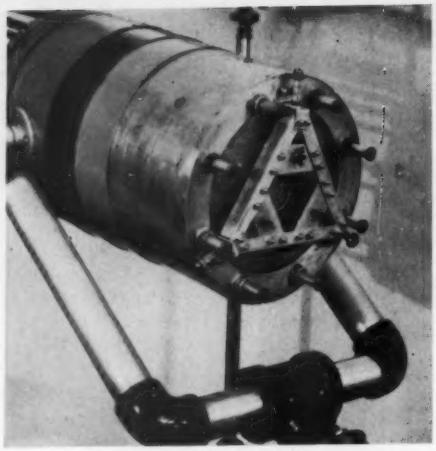

Fig. 4. The mirror support.

inch in diameter. The polar axis is mounted in a ball bearing, and requires only a ¼-pound starting force. Mr. Skart intends to add a motor drive shortly.

An ingenious arrangement developed by this Detroit amateur is the use of a number of aluminum sleeves for his eyepieces which bring the focal plane of each eyepiece into the same position in the eyepiece support. Each sleeve is of a width correct for the eyepiece, to which it is fitted just beneath the eye cap. For instance, for the highest power eyepiece used, no sleeve is needed at all; the ring is 0.563 inch wide for an eyepiece of ½-inch focus, 0.844 inch for a 1-inch eyepiece, and 1.656 inches for an ocular of 2⅛ inches focal length.

These sleeves therefore permit the observer to change eyepieces momentarily without losing focus, as each eyepiece is self-focusing. Mr. Skart suggests that if manufacturers turned on a lathe the shoulder of the eyepiece for each size designed, it would be a blessing to amateurs.

Homemade Refractor

MAKING my 5-inch refractor has thrilled me more than anything I have ever attempted in my work as an amateur telescope maker. I believe that many other amateurs would try to build refractors but have the same doubt in their minds that I had for so long; believing that it was a job for professionals only. My instrument required about a year of interesting spare-time labor, and has been very satisfactory in use. Its total material cost was about 55 dollars.

The crown and flint disks, 5" in diameter, were obtained for 36 dollars from an optical glass concern. The radii were figured according to the formulae given by Ellison in **Amateur Telescope Making.** Four 5" disks of plate glass were used for tools, a separate tool for each surface. The four surfaces were ground and polished to their proper curves. The third and fourth surfaces being concave, they were tested with a Foucault tester. The first and second surfaces (crown lens) were tested upon a distant light source. The curves were figured to give a 75" focal length, making an f/15 objective; the final result measured 74¾".

The tube, mounting, and tripod were

LARGE TELESCOPE OBJECTIVES

2¾" O. D. 15" focal length

New — Achromatic — Coated

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Made to rigid government specifications by one of the world's leading producers of precision optical instruments.

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Same as above but unmounted —
Stock # 100B ..... $14.00 ea.

OBJECTIVE, COATED ACHROMAT, beautifully mounted for telescopic use. Clear aperture 1⅞ inches, focal length 27 inches. Long focal ratios like this are very scarce in war surplus stocks.

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EYE PIECE, HUYGHENIAN, E.F.L. one inch. Nickel plated brass mount. 15/16" O.D. x 1¾" long.

Stock # 23 ..... $2.75 ea.

ACHROMATIC ERECTING LENS SYSTEM, six elements, coated and mounted in 1¼ inch dia. by 1⅜ inch long aluminum mount. This is a really high grade erector made by the same company and for the same instrument as our # 100 A&B objectives.

Stock # 101 ..... $5.00 ea.

EYE PIECE E.F.L. one inch, removable reticle, coated lenses, field lens is an achromat, 1-1/16" dia. threaded mount. Clear aperture eye lens 15/16 inches. This eye piece was made for M-12 panoramic telescope.

Stock # 20 ..... $3.75 ea.

EYE PIECE E.F.L. ¾ inch, both eye and field lenses achromatic and coated. In focusing mount threaded for ¾" holder. Knurled focusing adjustment. Clear aperture eye lens 43/64 inch. Removable reticle.

Stock # 21 ..... $5.00 ea.

EYE PIECE—Large, from aircraft sighting station. In 2⅞ inch dia. threaded aluminum mount with locking ring. E.F.L. approx. 2 inches. Coated optics, clear aperture eye lens over 1¾ inches.

Stock # 22 ..... $5.00 ea.

Please use Stock No. when ordering.

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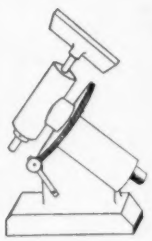

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4¼-inch .. $24.00 6-inch .. $40.00
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4" Equatorial with finder $750.00
6" Observatory 'scope priced on request.
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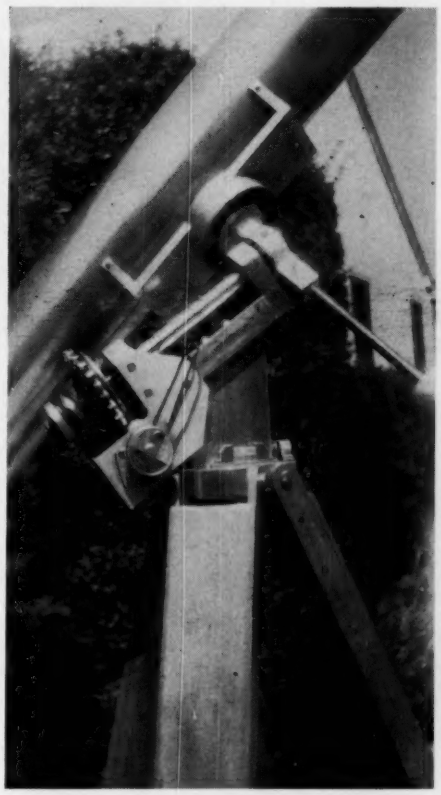
LABORATORY OPTICAL CO.
76 Interhaven Ave. Plainfield, New Jersey

made of war surplus materials. For the tube I used a piece of sheet aluminum 0.032" thick, and had it rolled by a plumber. All I had to do was to fasten the seam with small brass bolts and nuts. I found some metal rings 6" in outside diameter and ¼" thick, which I used to support the inside of the tube, as it had been rolled to an inside diameter of 6". Five rings were used, in addition to the objective



The mounting of a 5-inch refractor made by Dr. W. H. Letson, of Glendale, Calif. Most of the mounting parts are of aluminum, and a clock drive is included.

cell and focusing tube bushing. The tripod was made of hardwood.

A clock drive is provided, consisting of a 110-volt A.C. clock movement with a shaft revolving at one revolution per hour. It has plenty of power to drive the instrument. A worm is attached directly to the clock shaft and drives a 24-tooth worm gear, giving solar rather than sidereal time, but since the instrument is not used for photography, the drive is sufficiently close to keep an object in the field of view for a long time.

The motor mounting was made of 3/16" aluminum sheet, which is sufficiently rigid to withstand the end thrust of the worm. The main mounting was built up of 1¼" slab aluminum, using 1½" x ¼" bolts. The cradle was made of ½" aluminum slab.

DR. W. H. LETSON
311 North Central Ave.
Glendale, Calif.

GLEANINGS is always ready to receive reports and pictures of amateur instruments and devices, and is open for comments, contributions, and questions from readers.

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12 mm Dia.	80 mm F.L.		ea.	$ .50
14 mm Dia.	60 mm F.L.	coated	ea.	1.25
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23 mm Dia.	184 mm F.L.	coated	ea.	1.35
25 mm Dia.	122 mm F.L.	coated	ea.	1.25
26 mm Dia.	104 mm F.L.	coated	ea.	1.25
29 mm Dia.	54 mm F.L.	coated	ea.	1.25
29 mm Dia.	76 mm F.L.	coated	ea.	1.25
31 mm Dia.	124 mm F.L.	coated	ea.	1.50
31 mm Dia.	172 mm F.L.	coated	ea.	1.25
32 mm Dia.	132 mm F.L.		ea.	1.50
34 mm Dia.	65 mm F.L.	coated	ea.	1.50
38 mm Dia.	130 mm F.L.		ea.	1.50
52 mm Dia.	224 mm F.L.		ea.	3.25
58 mm Dia.	215 mm F.L.		ea.	4.50
PENTA PRISM 19 mm Face			ea.	1.00
PENTA PRISM 26 mm Face			ea.	3.00
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These superb telescopes were made by the finest optical houses in America. Length 22½ inches, contains 6 coated lenses, five of them achromats. The high resolving power of the lenses will bring out great detail. 36° Field of View, 3X. Eyepiece Lens Dia. 29m/m E.F.L. 1¼". Fixed focus. Objective 25m/m Dia. Also reticle, three detachable colored filters. Postpaid, $7.50

ACHROMATIC TELESCOPE OBJECTIVE 3" (76mm) dia., 15" (381 mm) F.L. Magnesium-fluoride coated and cemented. Mounted in aluminum cell. O.D. 3⅝". .... **Postpaid ea. $20.00**

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5 POWER TANK ARTILLERY TELESCOPE (M71) Brand new. Coated optics. Completely assembled. Value $345.00. ..... ea. **$29.50**

WIDE ANGLE EYEPIECE—All coated optics, mounted in focusing cell, 2" clear aperture, 1½" F.L. 3 Achro. lenses. Value $125.00. Perfect. ea. **$9.50**

OPTICAL LENS BENCH, a necessity for designing your own telescopes or optical instruments. Complete bench with four lens holders. **Postpaid $8.50**

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OBSERVER'S PAGE

Greenwich civil time is used unless otherwise noted.

Observing News and Notes from Amateurs

The big sunspot group on the northern side of the sun passed the central meridian Thursday and Friday, July 17-18th, and was about 206,000 kilometers long on the 18th. The principal spot of this group on the eastern end, visible with the naked (but protected) eye, had a diameter of about 51,150 kilometers. I measured this group late on Friday with a simple crosshair and a stop watch.

HERBERT LUFT
97 Fort Washington Ave.
New York 32, N. Y.

On a number of occasions I have made drawings of the appearance of Jupiter's satellites as I observed transits or occultations, making the sketches on the spot, by match light, which works pretty satisfactorily except that it is easy to burn a finger.

I believe it would be greatly appreciated by your readers who are strictly amateurs, like myself, if you would run an article explaining how the seeing scale (from 1 to 10 I believe) is determined. As far as I can tell, I have had only one night in the last year when the seeing was 10—that was the night when I could plainly see the double double in Epsilon Lyrae with my Tinsley 4-inch refractor, with 120x.

I now have converted a 9-mm. Busch eyepiece that I used with my 2½-inch Busch refractor, purchased some 25 years ago, and with this eyepiece I get a power of around 180 or 200; it is exceptionally clear with very good definition.

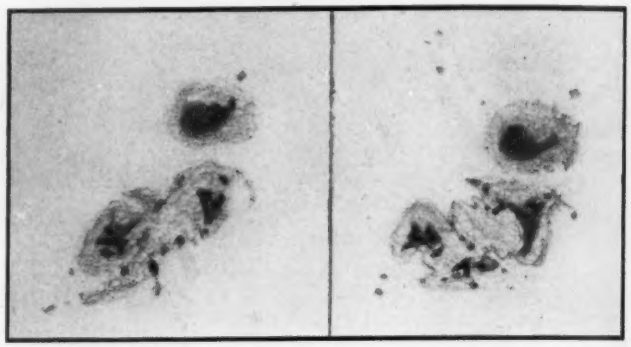
At present, I am trying to interest the Boy Scouts in our town in building a 4-inch reflector, as there is quite a little interest among the first-class scouts who want to get their merit badges on astronomy. Incidentally, the test for that merit badge is no easy one!

There are only two other astronomy enthusiasts in our town of some 13,000 population: Daryl Miller, who built a 10-inch reflector, and Henry Cavagnolo, who has built a very fine 8-inch reflector.

R. M. BLALACK
220-19th St., Merced, Cal.

The sunspot group shown in the accompanying drawings was evidently associated with the aurora on the night of July 17-18th. The pencil drawings give a general idea of the spots and their changes as they appeared to me. They were observed by projection through an old telescope, mounting by Fauth and Co., Washington, D.C., a 5-inch refractor which I had to diaphragm down to 4¼ inches. The telescope is mounted on top of the chemistry building here at South Dakota State College, where I am now attending summer school.

The drawing on the left was made from 3 to 4 o'clock on the afternoon of July 17th. It was a large, easy naked-eye group, and appeared as on the right from 10:15 to 11:00 a.m. on July 18th.



Drawings of the sunspot group of July 17-18, 1947, by Harold Leinbach, as seen by projection through a refractor of 4¼-inch aperture.

The outstanding feature of the aurora was an arc, 10° or so wide, highest directly to the north at about 25° to 30° altitude, and extending evenly to the west and east, not quite reaching the horizon on either end. This band was brilliant, and a slight greenish tint was noticed. On the extreme west end, pink streamers formed, extending upward to about 50°; this was the only place where any red or pinkish color was noticed. Small streamers formed below

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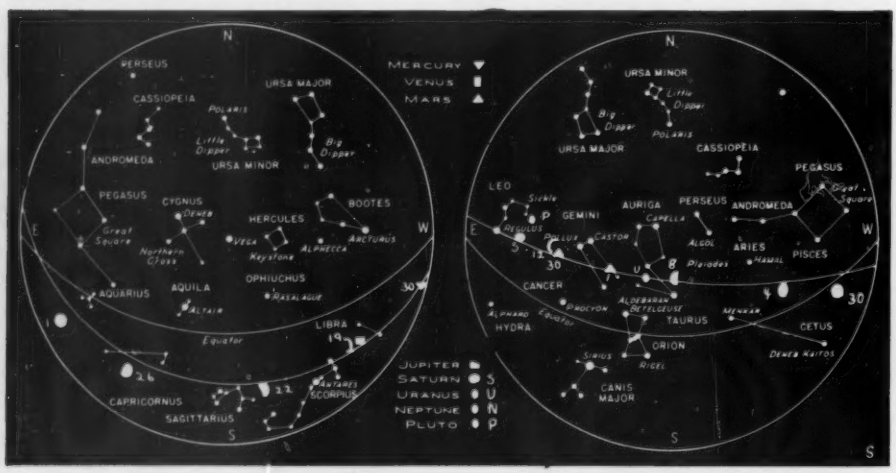
THE MOON AND PLANETS IN THE EVENING AND MORNING SKIES



In mid-northern latitudes, the sky appears as at the right at 5:30 a.m. local time on the 7th of the month, and at 4:30 a.m. on the 23rd. At the left is the sky for 7:30 p.m. on the 7th and 6:30 p.m. on the 23rd. The moon is shown for certain dates by symbols which give roughly its phase. Each planet has a special symbol, and is located for the middle of the month, unless otherwise marked. The sun is not shown, although at times it may be above the indicated horizon. Only the brightest stars are included, and the more conspicuous constellations.

Sun crosses the equator southward on September 23rd at 21:29 GCT, and autumn commences in the Northern Hemisphere; spring in the Southern.

Mercury will be in the evening sky all month, but difficult to see, except perhaps for the last few days of September, when it sets about three quarters of an hour after the sun, and is of magnitude 0.0.

Correction: Mercury's western elongation last month was incorrectly called an eastern elongation in the August issue.

Venus passes into the evening sky on September 3rd, at superior conjunction. But as its motion relative to the sun is very slow, it will not be visible until October.

Mars, in Gemini, rises shortly after midnight. On the 20th, it is about 5° south of Pollux and only slightly fainter; Mars' magnitude is +1.3, and the star's +1.2. The planet's rapid motion brings it into Cancer by the month's end, and about 20° west of Saturn.

Jupiter may be viewed in the evening sky fairly low in the southwest, 15° west of Antares. It sets about 2½ hours after the sun.

Saturn becomes a more conspicuous object in the morning sky. It follows Mars, rising about two hours later than the ruddy planet, but precedes Regulus by an hour.

Uranus may be viewed after midnight in eastern Taurus, 3° from Zeta Tauri, and 1° south of a 5th-magnitude star, 132 Tauri. Its position on the 15th is $5^h\ 43^m$, +23° 31′ (1947).

Neptune cannot be seen due to its nearness to the sun.

EDWARD ORAVEC

the arc, and some above it, usually of the same greenish color as the arc. There was considerable diffuse light above the arc. Observation was from about 10:15 to 11:45 p.m. CST, but not steady. Three meteors were observed in this region of the sky, all between 1st and 2nd magnitude.

HAROLD LEINBACH
929-10th St.
Brookings, S. D.

In the August issue I noticed some inquiries concerning where one may procure observing manuals (letter from D. A. Beekhuis, page 9). I am an amateur astronomer and would like to help some of these people out in their search for the proper manuals. Unfortunately, most of the good ones are almost impossible to get. Over the past six years I have been collecting some valuable books for the amateur, and am now in a position to trade these books for equipment on a non-profit basis. The books I have are:

Celestial Objects for Common Telescopes, Webb, 4th edition, 1881.

1001 Celestial Wonders As Observed With Home Built Instruments, Barnes, 1927.

Star Atlas, Klein, 1888. Includes a list of about 700 double stars, nebulae, clusters, and so on. Maps and astronomical drawings and photographs.

The Star Guide, Latimer Clark and Herbert Sadler, 1886. List of about 400 doubles, etc. Special list of objects for 4-inch to 7-inch refractors. Test objects for refractors from 2 to 7 inches. Introduction to Webb.

Pleasures of the Telescope, Serviss, 1910. For refractors from 3- to 6-inch.

Hours With a Three-Inch Telescope, Noble, 1886.

Geography of the Heavens, Burritt, 1839.

Telescope Work, Denning, 1891.

I shall be glad to have anyone communicate with me who is interested in these books.

ERWIN LUBIN
215 Schenectady Ave.
Brooklyn 13, N. Y.

VARIABLE STAR MAXIMA

September 1, R Cassiopeiae, 6.5, 235350; 2, RT Cygni, 7.4, 194048; 3, T Columbae, 7.6, 051533; 3, R Carinae, 4.6, 092962; 8, T Aquarii, 7.9, 204405; 20, S Herculis, 7.6, 164715; 27, R Bootis, 7.3, 143227; 30, S Ursae Majoris, 7.9, 123961.

October 1, U Cygni, 7.6, 201647; 3, X Ophiuchi, 6.9, 183308; 7, W Andromedae, 7.5, 021143a; 7, R Ophiuchi, 7.6, 170215; 13, R Leo Minoris, 7.2, 093934.

These predictions of variable star maxima are made by Leon Campbell, recorder of the AAVSO, Harvard College Observatory, Cambridge 38, Mass. Serious-minded observers interested in making regular telescopic observations of variable stars may write to Mr. Campbell for further information.

Only stars are included here whose mean maximum magnitudes, as recently deduced from a discussion of nearly 400 long-period variables, are brighter than magnitude 8.0. Some of these stars, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).

OCCULTATION PREDICTIONS

September 7-8 **103 Tauri** 5.5, 5:04.9 +24-11.8, 23, Em: **A** 8:34.7 −1.1 +1.7 246; **B** 8:38.2 −1.2 +1.4 255; **C** 8:23.6 −1.0 +1.8 242; **D** 8:28.7 −1.1 +1.4 258; **E** 8:12.4 −0.8 +1.3 266; **F** 7:54.8 −0.4 +1.3 253.

10-11 **Lambda Cancri** 5.9, 8:17.4 +24-11.4, 26, Em: **A** 8:48.2 −1.1 −0.7 325; **B** 8:42.6 ... ... 345; **C** 8:45.8 −0.8 −0.3 317; **D** 8:37.1 ... ... 347.

23-24 **248 B Sagittarii** 5.6, 19:26.6 −27-05.7, 9, Im: **A** 23:27.5 −2.2 0.0 107; **B** 23:25.4 −2.0 +0.2 103; **C** 23:17.2 −2.2 0.0 113; **E** 22:53.1 −1.3 +0.4 120; **F** 22:53.8 +0.4 −3.2 160.

27-28 **Tau Aquarii** 4.2, 22:46.8 −13-52.4, 13, Im: **A** 23:58.0 −1.0 +2.3 28; **B** 00:04.1 −0.9 +2.3 22; **C** 23:44.7 −1.0 +2.4 32; **D** 23:54.2 −0.9 +2.5 24; **E** 23:35.1 −0.7 +2.4 32. Em: **A** 1:03.0 −2.0 +0.9 277; **C** 0:50.6 −1.8 +1.0 276; **E** 0:31.9 −1.0 +1.1 283; **F** 0:13.8 −0.7 +1.3 263.

October 4-5 **Tau Tauri** 4.3, 4:39.1 +22-51.4, 20, Im: **A** 2:09.6 +0.2 +1.2 87; **B** 2:13.5 +0.2 +1.3 82. Em: **A** 3:00.5 +0.2 +1.8 233; **B** 3:05.9 +0.1 +1.7 239; **D** 3:03.9 +0.2 +1.6 242.

5-6 **139 Tauri** 4.9, 5:54.7 +25-57.0, 21, Em: **A** 10:14.1 −1.8 +2.0 227; **C** 9:56.2 −1.7 +3.6 211; **D** 10:04.1 −1.7 +1.7 234; **E** 9:38.7 −1.4 +2.4 229; **F** 8:59.2 ... ... 197; **G** 9:24.9 −1.2 +0.8 287; **H** 9:01.8 −0.7 +1.5 256; **I** 9:14.1 −1.0 +0.7 295.

6-7 **39 Geminorum** 6.1, 6:55.5 +26-09.2, 22, Em: **A** 8:27.7 ... ... 206; **B** 8:38.2 −0.9 +3.0 223; **C** 8:04.7 ... ... 186; **D** 8:28.0 −0.7 +3.1 222; **E** 8:11.9 −0.2 −2.7 224; **F** 7:39.0 ... ... 189; **G** 8:22.5 −0.4 +1.2 281; **H** 8:02.5 +0.1 +1.4 254; **I** 8:18.3 −0.2 +1.0 288.

6-7 **40 Geminorum** 6.3, 6:56.2 +25-59.3, 22, Em: **G** 8:36.1 −0.1 +2.0 242; **H** 8:03.8 +1.0 +2.9 207; **I** 8:33.4 +0.1 +1.8 249.

For selected occultations (visible at three or more stations in the U. S. and Canada under fairly favorable conditions), these predictions give: evening-morning date, star name, magnitude, right ascension in hours and minutes and declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, GCT, a and b quantities in minutes, position angle; the same data for each standard station westward.

Longitudes and latitudes of standard stations are:

A	+72°.5, +42°.5	**E**	+91°.0, +40°.0
B	+73°.6, +45°.6	**F**	+98°.0, +30°.0
C	+77°.1, +38°.9	**G**	+114°.0, +50°.9
D	+79°.4, +43°.7	**H**	+120°.0, +36°.0
		I	+123°.1, +49°.5

The a and b quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude respectively, enabling computation of fairly accurate times for one's local station (long. Lo, lat. L) within 200 or 300 miles of a standard station (long. LoS, lat. LS). Multiply a by the difference in longitude (Lo — LoS), and multiply b by the difference in latitude (L — LS), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Greenwich civil time to your own standard time.

For additional occultations consult the American Ephemeris and Nautical Almanac and the British Nautical Almanac, from which these predictions are taken. Texas predictions were computed by E. W. Woolard and Paul Herget.

MINIMA OF ALGOL

September 3, 5:54; 6, 2:43; 8, 23:32; 11, 20:20; 14, 17:09; 17, 13:57; 20, 10:46; 23, 7:35; 26, 4:23; 29, 1:12. October 1, 22:01; 4, 18:49.

GREENWICH CIVIL TIME (GCT)

TIMES used on the Observer's Page are Greenwich civil or universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the GCT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.

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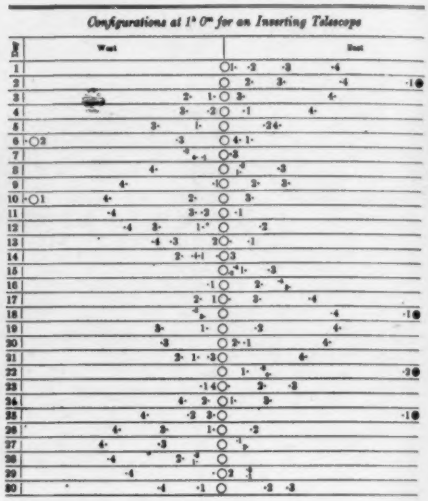
JUPITER'S SATELLITES

Note the rare combination of events occurring this month, when on the 14th (evening of the 13th in the United States) the four brightest Jovian satellites are to the west of the planet, and by the next evening all will have moved to the east side. A small telescope is needed to follow Jupiter's bright moons.

Jupiter's four bright moons have the positions shown below for the GCT given. The motion of each satellite is from the dot to the number designating it. Transits of satellites over Jupiter's disk are shown by open circles at the left, and eclipses and occultations by black disks at the right. Reproduced from the American Ephemeris and Nautical Almanac.



PHASES OF THE MOON

Last quarter	September 8,	3:57
New moon	September 14,	19:28
First quarter	September 22,	5:42
Full moon	September 30,	6:41
Last quarter	October 7,	10:29

SKY-GAZERS EXCHANGE

Classified advertisements are accepted for this column at 40 cents a line per insertion, six words to the line. Minimum ad is three lines. Remittance must accompany orders. Address Ad Dept., Sky and Telescope, Harvard Observatory, Cambridge 38, Mass.

FOR SALE: Early model 3″ refractor telescope, fair condition, excellent lens, French make. $50.00. R. E. Hart, Penn Yan, N. Y.

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EYEPIECES: Achromatic, coated, wide angle, 1.1″ focal length, 1¼″ diameter, $5.00. Leroy Benfer, 6130 Montrose Rd., Cheverly, Md.

TERMINOLOGY TALKS- J. Hugh Pruett

LAST MONTH we discussed angles and arcs, and their measurement in terms of the degree and its subdivisions. Other systems of measurement have been devised, and one is now used to a considerable extent. To understand its application, we should first examine the significance of pi (Greek letter π).

Pi

Those of us not too far removed by age or other considerations from our school geometry and arithmetic will recall that if the diameter of a circle is known, its circumference is easily calculated. The early Babylonians and Hebrews assumed that the diameter multiplied by 3 equaled the circumference. The noted Greek, Archimedes, in the 3rd century B. C. showed that this multiplier was between 3 1/7 and 3 10/71. Even nowadays we sometimes use 3 1/7 for short. A few centuries later another learned Greek, Ptolemy, was using a value which if carried to only four decimal places became 3.1416, a number which today is quite familiar. Sticklers for exactitude will likely get more of a mathematical thrill from using 3.14159-26536....

It can be proved definitely without actually calculating the figures that there is no end to the decimal places required to express this ratio completely, and that the figures never get to repeating themselves in any orderly fashion. Pi is said to have been computed in modern times to 707 places. A later investigator, however, reported an error at the 528th decimal place, a condition which seemingly throws the figures which follow into the discard.* Surely the ancient 3.1416 is sufficiently accurate for most of us, and far less exhausting to work with than even a few more figures.

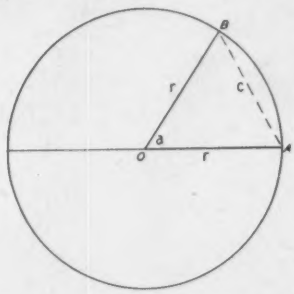
In most formulas the radius, or one half the diameter, is used. Representing this by r, the diameter by D, and the circumference by C, we have the very simple expression:

$$C = \pi D = 2 \pi r.$$

Radian

The angular unit of the ancient sexagesimal system, the degree, has somewhat of a natural derivation in that it represents approximately the arc through which the sun seems to move eastward daily among the fixed stars. But in modern times another unit, which may be termed both natural and exact, has been widely employed. This is the radian, the unit in the circular system of angular measurement. This system came into use around the year 1700, and is now so interwoven into our mathematics that it would be hard to eradicate it even should we wish to do so. The formulas of higher mathematics where angles are concerned are generally built on the assumption that radians, and not degrees, are the units to be used.

The meaning of "radian" is very easily illustrated. In the accompanying diagram we have a circle of radius r. Let us measure off on the circumference an arc AB which is exactly equal to r. The angle subtended at the center O (and perhaps less strictly the curved arc AB



itself) is then said to have a value of one radian. If the arc is decreased to one half the length of the radius, then the angle is 0.5, meaning, of course, 0.5 radian.

From what has been said above about pi, it is easily reasoned that a full circle contains 2π radians, or about 6.2832 radians. This is the value of 360° in radians, and one radian then equals 360°/6.2832 or 57°.3 (very nearly). There are 206,265 seconds of arc in one radian, a figure useful in several astronomical applications.

As just written, subdivisions of a radian are expressed in easily handled decimals.

If the angle a is very small, then the chord c (dotted straight line) from A to B is so nearly equal to the curved arc AB that its value may be substituted for the arc without appreciable error. This also has astronomical applications, as we shall see at a later date.

It seems that the term radian was definitely adopted about 1874. The English magazine *Nature*, in 1910, carried in several numbers letters from Dr. Thomas Muir and James Thomson, son of Professor James Thomson of Glasgow, in a controversy as to whether Dr. Muir or Professor Thomson actually was responsible for the term. Shortly before its introduction, the words "radial angle" were used in this connection. Dr. Muir claimed that in 1869 he eliminated the last syllable of each word, and by combining what remained came up with the fitting new term "radian." But Thomson was just as sure that his father in 1871, without any knowledge of its being used elsewhere, proposed it — and wrote it in a dictionary — and in 1873 used it in a set of examination questions. He graciously suggested that both men had independently introduced the word.

*See Astronomical Anecdotes, *Sky and Telescope*, V, 10, August, 1946.

Planetarium Notes

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STAFF: *Director*, Wagner Schlesinger. *Other lecturer:* Harry S. Everett.

September: AUTUMN SKIES. The more important constellation figures of the autumn evening skies will be shown fitted to the stars, and the ancient legends concerning them will be told.

October: STORY OF THE CALENDAR.

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September: STARS AND ATOMS. The story of the big and small in the universe, the close connection between stars and atoms, and their effects on human beings.

October: MYSTERY OF THE NORTHERN LIGHTS.

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October: TRIP TO THE MOON.

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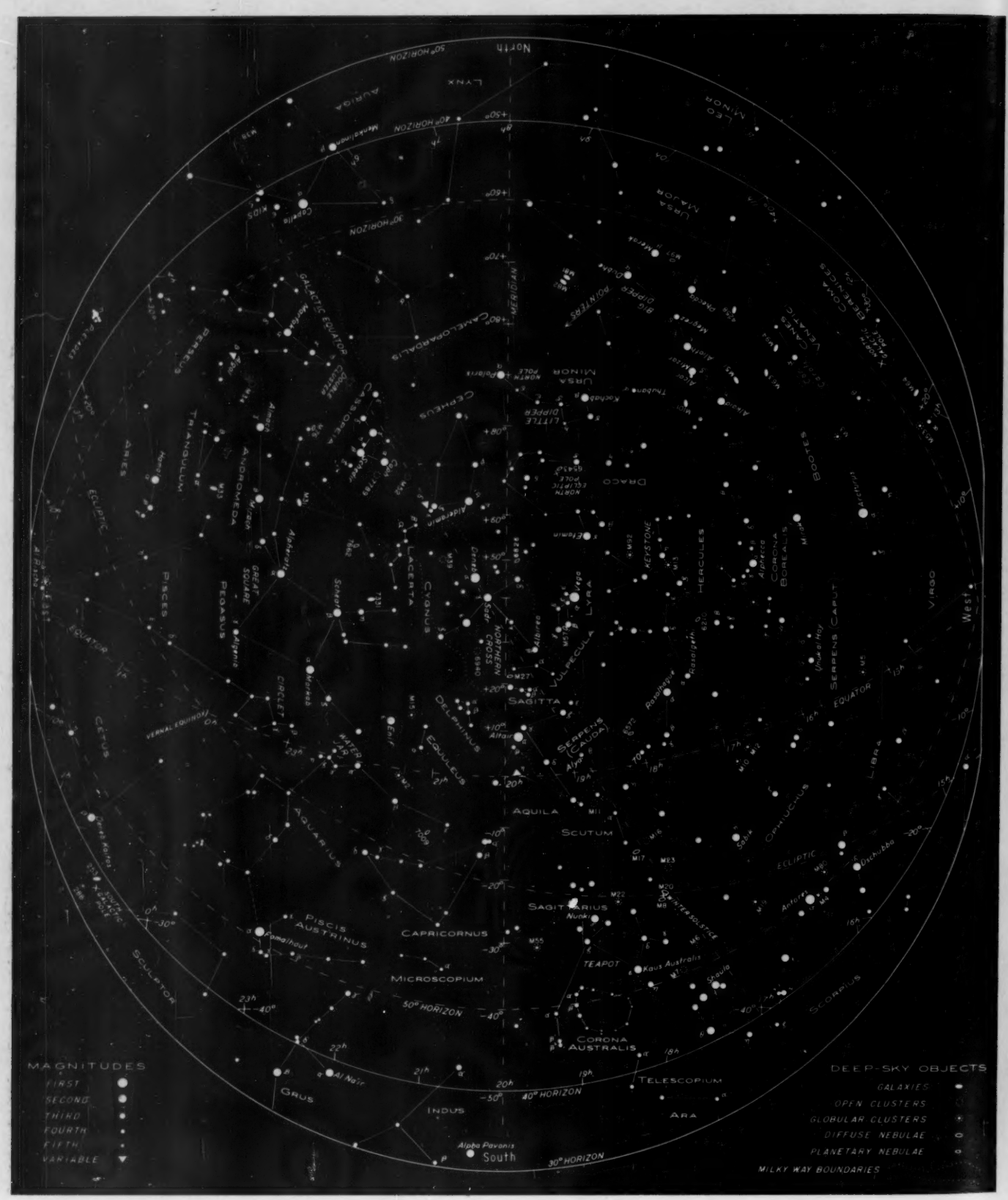
September: A ROCKET TRIP AROUND THE WORLD. This month take an imaginary rocket trip around the world and enjoy the changing sky panorama as seen from various parts of the earth.

October: FALL SKIES.



DEEP-SKY WONDERS

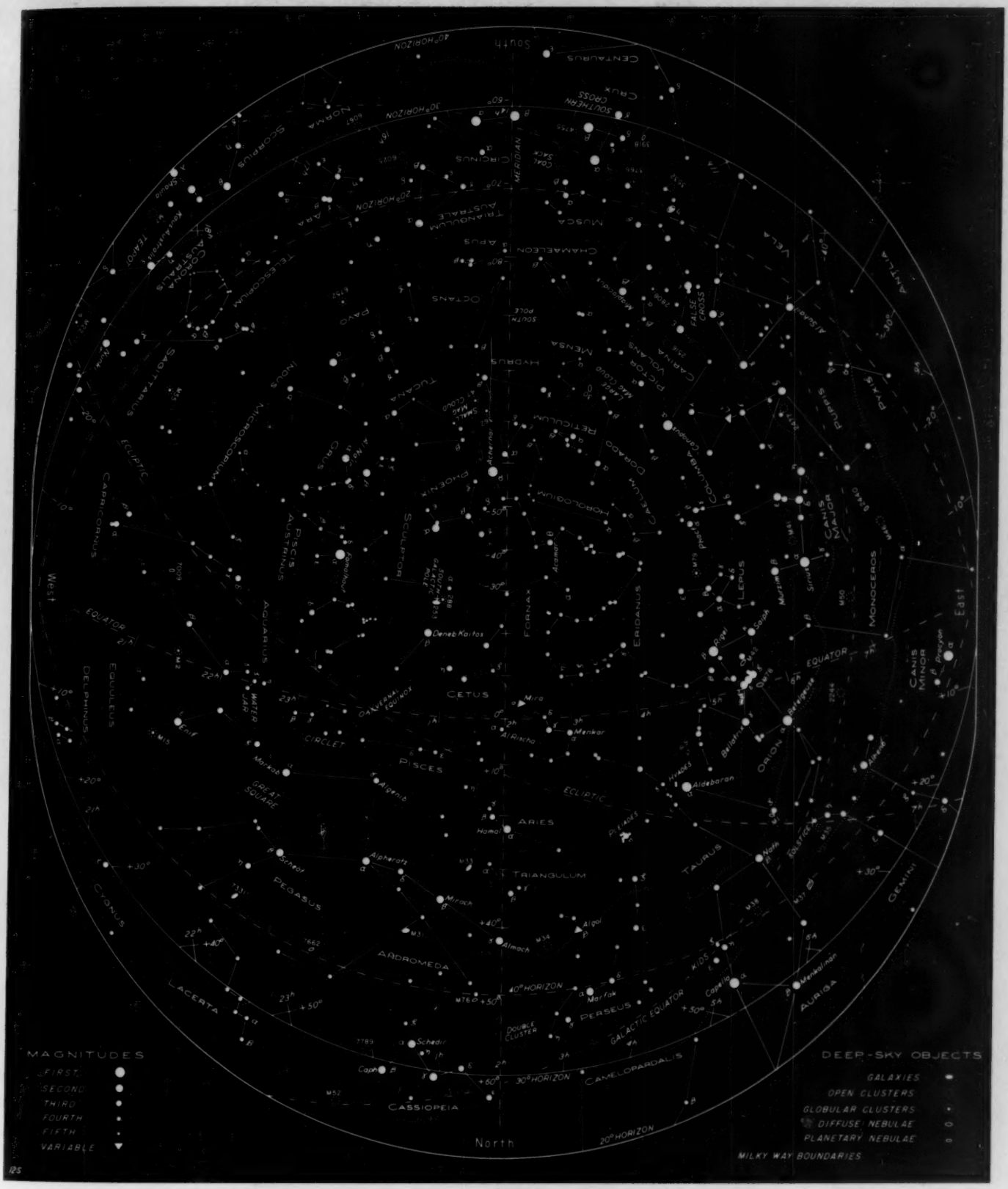
IN CAPRICORNUS and Aquarius the diligent observer will find objects worth his search. NGC 6981, M72, $20^h\ 29^m$, $-12°\ 55'$, is a small, faint globular cluster of 2′ diameter. It is well described in Smyth's **Bedford Catalog**, although he lists it under Capricornus. The modern revision of the constellation boundaries places it in Aquarius. A little over 1° east is NGC 6994, M73, a galactic cluster not included in amateur handbooks.

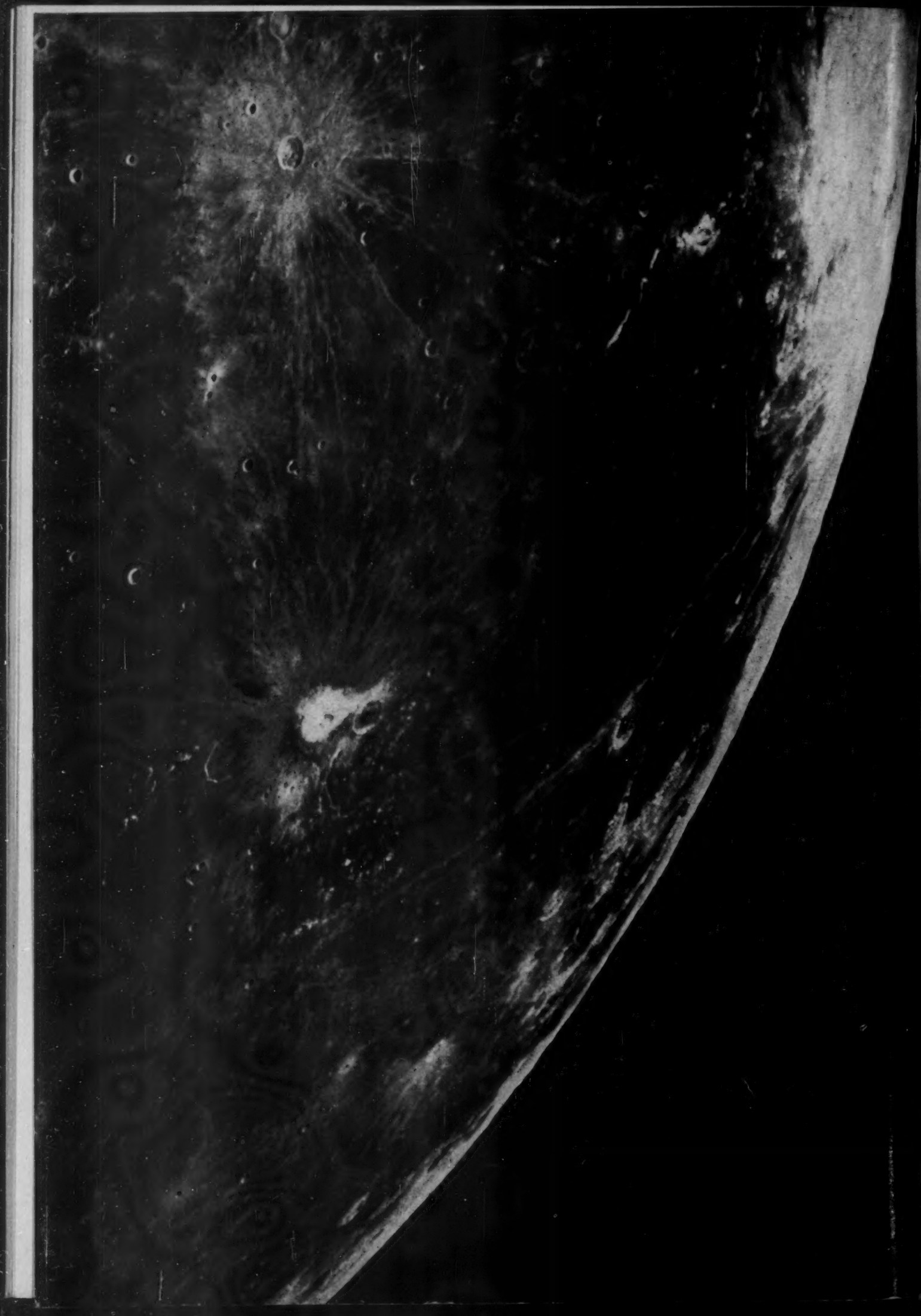
NGC 3169, 14, $20^h\ 59^m$, $-11°\ 22'$, is the famous Saturn nebula, a giant planetary 35″ x 17″. NGC 7099, M30, $21^h\ 35^m$, $-23°\ 38'$, is a globular cluster 6′ in diameter, bright. In a 10-inch reflector, the same rays of stars run out that M13 evidences.

Amateurs who wish to change these 1900 co-ordinates to a later or earlier date will find a handy precession table for a 50-year interval on the inside back cover of the **Observer's Handbook** for 1947, published by the Royal Astronomical Society of Canada, 3 Willcocks St., Toronto, at 25 cents. WALTER SCOTT HOUSTON

STARS FOR SEPTEMBER

from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of the month, respectively. The 40° north horizon is a solid circle; the others are circles, too, but dashed in part. When facing north, hold "North" at the bottom, and similarly for other directions. This is a stereographic projection, in which the flattened appearance of the sky itself is closely reproduced, without distortion.



EVENING STARS FOR SOUTHERN OBSERVERS

THIS CHART is prepared for a basic latitude of 30° south, but it may be used conveniently by observers 20 degrees on either side of that parallel. These southern charts appear in alternate months, but always two or three months in advance, to allow time for transmission to observers in any part of the world. The sky is here shown as it appears on Nov. 7th at 11 p.m., Nov. 23rd at 10 p.m., Dec. 7th and 23rd at 9 p.m. and 8 p.m., respectively. Times for other days vary similarly, four minutes earlier per day. These are local mean times which must be corrected for standard time differences. The 30° horizon is a solid circle; the other horizons are circles, too, those for 20° and 40° south being dashed in part. When facing south, hold "South" at the bottom, and similarly for other directions. Observers in the tropics may find north circumpolar stars on any of our northern star charts. For other charts in this series, see issues of alternate months from November, 1945, to July, 1946; and October, 1946, to August, 1947.